

VOL. X, PART I

QUARTERLY

JANUARY, 1915

THE
AGRICULTURAL JOURNAL
OF INDIA



AGRICULTURAL RESEARCH INSTITUTE, PUSA

PUBLISHED FOR
THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

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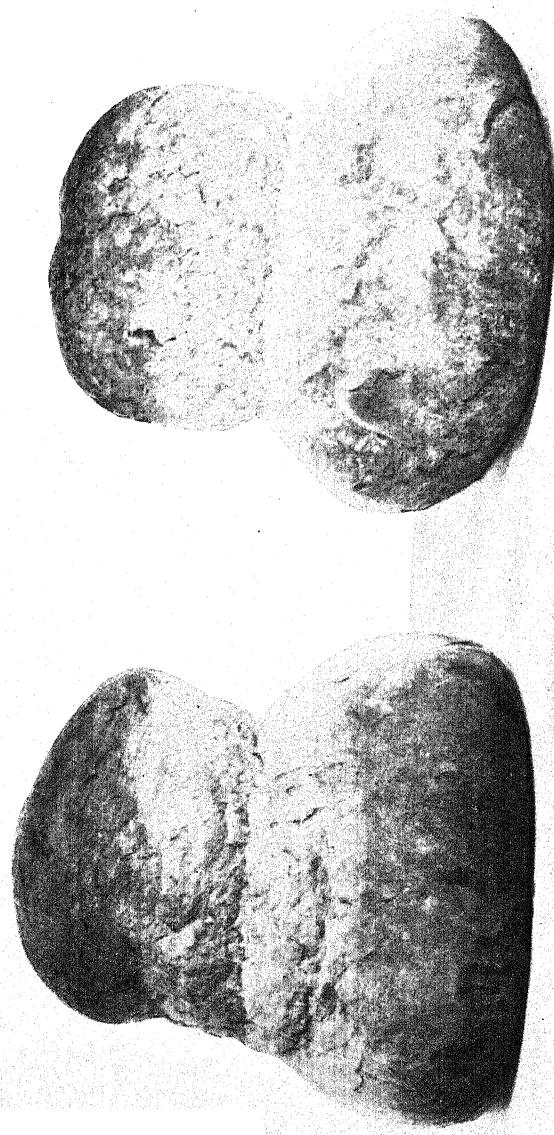
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CONTENTS

| | <i>Page</i> |
|--|-------------|
| PUSA 12 <i>Albert Howard, C.I.E., M.A., and Gab- rielle L. C. How- ard, M.A.</i> ... | 1 |
| CO-OPERATIVE CATTLE INSURANCE ... <i>G. K. Walker, C.I.E., F.R.C.V.S.</i> ... | 9 |
| SOME OBSERVATIONS ON UPPER BURMA PADDY (GROWN UNDER IRRIGATION) ... <i>E. Thompson, B.Sc.</i> | 26 |
| SUGAR PRODUCTION IN THE UNITED PRO- VINCES, FROM AN ENGINEER'S POINT OF VIEW <i>William Hulme</i> ... | 54 |
| CATTLE FEEDING EXPERIMENTS IN DENMARK <i>H. E. Annett, B.Sc., F.I.C.</i> ... | 63 |
| THE IMPROVEMENT OF CANE CULTIVATION IN THE SOUTH CANARA DISTRICT ... <i>H. C. Sampson, B.Sc.</i> | 76 |
| NOTES ON THE CULTIVATION OF BERSEEM ... <i>Capt. A. S. Marriott</i> | 81 |
| NOTES | 86 |
| REVIEWS | 105 |

PLATE I.



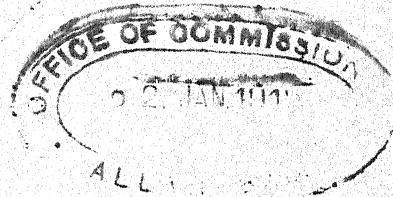
MANITOBA (No. 2 NORTHERN).

PUSA 12 (GURDASPUR).



CHOICE WHITE KARACHI.

LOAVES FROM CANADIAN AND INDIAN WHEATS.



PUSA 12.

BY

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AND

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UP to the year 1908, it was generally believed in the wheat trade that India could only produce wheats of relatively poor grain quality. This conclusion was a natural one, and was based on a long practical experience of the wheats exported from the country. In 1908 and succeeding years, a large number of Indian wheats were sent to England for complete milling and baking tests, the work being undertaken by Mr. A. E. Humphries, a former President of the Incorporated National Association of British and Irish Millers. These samples included many of the wheats of Northern and Central India as well as a large number of new varieties obtained at Pusa by selection and hybridization. The reports¹ on the behaviour of these kinds in the mill and bakehouse showed that, as far as the wheats of Northern and Central India are concerned, the current ideas as to the lack of quality in the Indian wheats of commerce were amply justified.

Many of the Pusa varieties, however, behaved quite differently and proved to be free milling and to yield flour and loaves of the same class as those produced from the strongest North American grades. The relation of the Pusa varieties to Manitoba wheat on the one hand, and to the present Indian wheats of commerce on the other, will be evident on referring to the Plate opposite.

¹ Howard and Howard, *Bulletins 14, 17, and 22, Agr. Research Institute, Pusa, 1908, 1910, and 1911.*

All these high quality wheats were originally obtained either by selection or hybridization among the large collections of Indian wheats made at Pusa in 1905 and subsequent years. Some of the best were found occurring naturally and in large proportion among the wheats commonly cultivated in North Bihar, but in these cases high grain quality was associated with low yielding power and poor straw. It is probably on account of their poor cropping power that these North Bihar wheats have not spread to other tracts in India. Nothing approaching high grain quality, however, was discovered in Central or in Northern India, although the wheats of the Punjab¹ were for the most part grown in pure culture at Lyallpur and afterwards thoroughly tested in England.

After the discovery of the fact that wheats with high grain quality existed in India, the aim of the selection and hybridization work at Pusa was to unite these qualities with yielding power, strong straw, rust-resistance and the capacity to ripen quickly with the minimum amount of soil moisture. On account of the trade preference for a white wheat, it was necessary to combine all the above desirable qualities in a white rather than in a red variety. Further, in the work of replacing the existing crop by an improved variety it would be an obvious advantage if the new wheats possessed some easily recognisable field character, such as colour of chaff, which would readily differentiate them from the crop as ordinarily grown by the people.

In one important respect the problem was greatly simplified. As is well known, wheat is an important food grain in India, and of the 8,000,000 tons produced annually about 90 per cent. is consumed in the country, the remainder being exported to Europe. Any improvement in the grain itself, to be of importance, must therefore satisfy both the Indian consumer and also the Home miller. It is fortunate that the class of wheat most liked by the people for food is that which is worth the most money on the Home markets. This is a most important point and one which cannot be emphasized too strongly. On many occasions, the Pusa wheats along with

¹ Howard and Howard, *Mem. of the Dept. of Agr. in India (Bot. Series)*, Vol. II, No. 7, 1909.

ordinary samples have been shown to cultivators, and they invariably prefer for their own food the kinds which have done best in the milling and baking tests in England. A number of landholders and educated Indians have eaten these new wheats and are loud in their praises of the superiority of these types over those which can be purchased in the Indian market. Every year at Pusa there is a great demand for any surplus wheat from the Botanical area, while at the Dhcli and Bowarrah estates, where the new varieties are grown for seed on a large scale, a well marked preference for these wheats was at once shown by the people round about. At Dholi, the factory servants asked to be paid in wheat instead of in money.

The problem of producing wheats, characterized by high grain quality, high yield, improved straw, rust-resistance, and the power to ripen within the available growth period was eventually solved at Pusa. A number of wheats were produced, which, under experiment station cultivation, satisfied these conditions and were all that could be desired. At first sight, it might be thought that the whole matter was now settled and all that remained was to devise suitable methods of seed distribution. This, however, was by no means the case, and the present opportunity is taken of pointing out a very serious pitfall in variety trials carried out at experiment stations in India. This applies, in all probability, to other crops besides wheat and is likely to be of general interest. The agricultural conditions at a well-conducted experiment station are somewhat different from those which obtain among the ryots in the surrounding districts. The improved cultivation of the soil at an experiment station results in a greater supply of soil moisture for the wheat crop than is available in the average ryot's holding. It is likely, therefore, that a variety of wheat grown under the two sets of conditions will behave quite differently. This is found to be the case particularly if the maximum possible yield is desired at the experiment station. To obtain this maximum yield, the variety must be a late one so as to utilize to the utmost the available growth period and the ample supply of soil moisture. Under experiment station conditions, it is easily possible, with due

attention to cultivation, moisture conservation, and choice of soil to grow upwards of thirty maunds of wheat to the acre. If, however, these high-yielding varieties are grown by the cultivators quite different results are obtained. With defective preliminary cultivation and insufficient soil moisture, these late potentially high-yielding wheats do not reach maturity before the onset of the hot weather has begun to diminish the moisture in the soil. The result is a low yield, often of rather poorly filled grain. The experiment station results are thus reversed. Our experience at Pusa has shown that it is a good rule to avoid all high-yielding varieties with any tendency to lateness, and to confine attention to those sorts which ripen well within the available growth period. Such sorts, when grown under cultivators' conditions, have a margin of safety with which to meet the accidents of season. Experiment station results, therefore, must be used with caution, and considerable judgment is required in interpreting them. The highest yielding sorts are always apt to prove disappointing and the date of ripening and the appearance of the sample are perhaps more significant than the weight of the crop. These considerations explain the failure of Muzaffarnagar wheat among the cultivators in some tracts in the United Provinces and also that of Punjab Type 9 in the Punjab. It is true that both these varieties are capable of yielding heavily when the season is very favourable, if the supply of irrigation water is abundant and if the moisture-retaining capacity of the soil is all that can be desired. Such conditions for the wheat crop are the exception rather than the rule. It will be found that it is *that variety, which on the average does well, and in years of short moisture stands out from the rest*, and will be the one to select for general seed distribution.

The next subject investigated was the effect of environment on grain quality, an undertaking carried out in collaboration with Mr. H. M. Leake, the results of which have been published.¹ Briefly stated, it was found that in all the wheat-growing tracts of India, including the canal-irrigated tracts of the Punjab and the black

¹ Howard, Leake & Howard, *Mem. Dept. of Agr. in India (Bot. Series)*, Vol. III, No. 4, 1910, and Vol. V, No. 2, 1913.

soils of the Peninsula, the quality of the Pusa wheats was maintained. In the case of Pusa 12, the milling and baking results obtained with the samples from the Indus Valley and the black soil areas were better than those given by the Pusa sample and those from other stations on the Gangetic alluvium. Canal irrigation was found to have no harmful effect on the grain quality, and in the case of Pusa 12 grown at fourteen stations all over India in 1912, the best loaves were given by the wheat from Lyallpur. The loaf produced from the Gurdaspur sample in that year is shown in Plate I.

During the progress of the environment experiments, a number of the Pusa wheats were grown in most of the wheat-growing tracts of India by the cultivators themselves. Practically all the varieties tried did well in Bihar, the United Provinces, and in Central India. One variety (Pusa 12), however, gave equally good results in the Punjab, the United Provinces, South Bihar, and the Central Provinces, and proved itself to be the best wheat for India as a whole, both as regards yield and quality. The results of the trials of Pusa 12 in the Punjab in 1914 are referred to by the Director of Agriculture as follows :—

“ A special leaflet is being issued regarding Pusa 12, which has done well in the Punjab ” (*Punjab Agricultural Notes, Pioneer*, June 13th, 1914).

In the United Provinces the results with Pusa 12 are thus summed up by the Director of Agriculture in “ *United Provinces Agricultural Notes for April*,” in the *Pioneer* of May 16th last :—

“ This year a few selected Pusa wheats, which had done well at Cawnpore, were distributed in different parts of the Provinces, mainly in Oudh. Crop-cutting experiments were carried out to determine the yield in the cultivators’ fields. The reports now to hand show that one of these, No. 12, has done uniformly well under diverse climatic conditions, equally favourable reports being received from Benares and Saharanpur. One of its most attractive

features is that it requires comparatively little irrigation and is therefore suited to the well-irrigated tracts. Some of the Co-operative Societies, whose members have grown it with success, are arranging to put it down on a large scale next year."

In Bihar, Pusa 12 is being distributed by the Agricultural Department in the south of the Province, while in North Bihar a large consignment of this wheat grown on the Belsund indigo estate was sold in April last to the Calcutta mills at a premium of four annas a maund over local wheat.

In the Central Provinces, the Pusa wheats have been tested for some years in the Eastern Circle both on the Government Farms and also by the cultivators. Mr. Clouston, the Deputy Director of Agriculture, in a letter dated April 7th, 1914, describes the result of these trials as follows:—

" We have decided now to grow Pusa 12 under the Ramtek Tank. We have given out seed for the last two years and the cultivators were well pleased with the outturns they got from it. It is a fairly early wheat and is therefore suitable for areas not commanded by irrigation. As an irrigated wheat it yields very well.

It has done well at Raipur too; we intend to distribute all the seed we have available on the Raipur Farm to wheat-growers in the Chhattisgarh Division.

Distribution of this variety will be taken in hand in earnest this year. I wanted to make sure that it was without doubt the best of those I have under trial before booming it."

The result of the trials of this wheat by the cultivators in most of the wheat-growing tracts of India leaves no doubt that this variety is eminently suitable for growth practically all over India. Pusa 12 has another advantage in addition to its yielding power and quality, namely, its characteristic appearance in the field which distinguishes it at once from the country wheats. The beardless ears are long, with shining red chaff, and the straw is quite different in tint from that of most Indian wheats. Its appearance in the field and the large elongated

grain enable this variety to be instantly distinguished. In any scheme of seed distribution, which aims at replacing the existing wheats by a new kind, it is a great advantage if the improved variety can easily be recognized in the field and in the market.

The results of the trials of Pusa 12 show that the time has come for the establishment of an improved grade of white wheat over a large area of the wheat-growing tracts of India. While the various existing seed distribution schemes with this wheat are being developed by the Agricultural Department, and while the amount of surplus seed of this variety for trade purposes is being multiplied, another side of the matter must be kept in view. The wheat must be brought to the notice of the Home millers in the form of one or two experimental shipments so that they may have an opportunity of getting first-hand experience of its qualities and behaviour. This is essential if this variety is to realize quickly its full value on the market. As is well known, wheats are bought largely on appearance and reputation. Indian wheats are known to possess poor quality, so that this reputation has to be overcome before an improved Indian grade can fetch its proper price. One or two shipments of the new wheat placed on the various markets and brought to the notice of the trade will obviously be the best means of convincing all concerned that an improved grade has really been obtained. By the time these preliminary shipments have been made, there should be sufficient Pusa 12 wheat in India for the shippers to begin to supply the demand. After this, the future development of the trade will depend on the efficient organization of the seed supply, a matter which can be left to the various Circle officers in the wheat tracts. In order to obtain the seed for the preliminary shipments, it has been arranged to concentrate the bulk of the seed of Pusa 12 raised on the Dholi and Bowarrahs seed farms¹ in Bihar into a single Circle. The Central Circle of the

¹ An account of the seed supply of the Pusa wheats was published in the *Agricultural Journal of India*, Vol. IX, p. 247, 1914. Seed of Pusa 12 and of the other Pusa wheats grown for distribution can be obtained on application to Mr. E. C. Danby, Dholi P. O., Bihar, or to the Imperial Economic Botanist, Pusa, Bihar.

United Provinces has been selected for the work and the co-operation of Mr. B. C. Burt, the Deputy Director of Agriculture, has been secured. This Circle has been chosen partly on account of the local development of the Co-operative Credit movement and of the close working arrangements which exist between the Societies and the Agricultural Department. By means of the Co-operative Societies, an effort will be made to replace the existing wheats as far as possible by the new kind and to supply the trade with as much surplus seed as can be obtained. At the earliest moment, this will be secured for the first shipments to Europe. In the work of buying in the seed and in placing it on the markets in Europe to the best advantage, the interest and assistance of Messrs. Ralli Brothers have been secured. Mr. A. E. Humphries has very kindly undertaken to bring the matter before the Home millers and to assist in the establishment of the new grade in England as soon as the first shipment has been collected.

CO-OPERATIVE CATTLE INSURANCE.*

BY

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INTRODUCTION.

THE material benefits to be derived from co-operation in agriculture are fully recognized in those countries where it has been adopted. It has been found to put fresh life into agriculture, and it has been particularly beneficial to the small farmer. Agricultural Co-operative Societies have been formed for a great variety of purposes. They provide credit, buy, sell, and distribute produce on favourable terms, store grain, improve the breeds of farm stock, and insure property against various kinds of risks. The last-named branch of usefulness in its application to cattle is the subject of this paper.

In India the loss of his oxen is very disastrous to the small agriculturist. Without draught cattle he cannot till his land or move his produce. Periodical famines and pestilences occur in addition to ordinary risk. The price of cattle has gone up and is not unlikely to increase further. To repair exceptional and unforeseen losses of cattle it may be necessary for the small farmer to pledge his credit. A more desirable solution is advocated. By means of a well-organized system of cattle insurance a man can, in exchange for a small premium, provide himself with the necessary funds to replace his animals. A Cattle Insurance Society working in conjunction with a Cattle Breeding Society is an almost ideal

* A paper read at the Co-operative Conference held at Poona in August 1914.

arrangement that may be brought about in due course in favourable localities.

It is proposed to commence by providing an economical system of insurance against losses of cattle by means of co-operation. There are other advantages to be derived from a system of this kind. Co-operation tends to create a bond of identical interests among the members of its societies. It teaches the value of mutual help and spreads education. A system of mutual insurance of cattle is bound to cause greater attention to be paid to the conservation of the lives of valuable animals. Public opinion demands that animals insured in a mutual society are properly housed, tended, and fed, and that every possible advantage is taken of scientific knowledge in regard to the prevention and cure of disease. A well-organized and efficient veterinary service is a necessary adjunct in any scheme of cattle insurance, and every society should realize the need of obtaining expert assistance and advice in the care and treatment of its insured stock.

It is proposed to describe shortly what has been done in other countries in regard to cattle insurance, and then to discuss the means at our disposal for instituting a scheme in the Bombay Presidency suitable to its special requirements.

CATTLE INSURANCE IN OTHER COUNTRIES.

In many Western countries the success which has attended the formation of Co-operative Cattle Insurance Societies has been very remarkable. It is apparent from the available literature that in most places insurance was co-operative before it became commercial, and that as a rule it was conceived under Government supervision and with State assistance. Insurance has now become very general, and is exploited largely by Joint Stock Companies which insure against a great variety of risks. These organizations undoubtedly serve a useful purpose but as they are interested in making profits and spend considerable sums in managing expenses, which the insured has to pay for, they are not likely to appeal to the small agriculturist in the same way as co-operative insurance does. Joint Stock Companies are not usually very keen on live-

stock insurance, as it entails considerable local supervision of a special character in order to prevent fraud. The consequence is that mutual live-stock insurance flourishes and appears likely to continue to do so.

Mutual cattle insurance exists in England, Germany, France, Italy, Austria, Norway, Sweden, Denmark, Holland, Belgium, and Switzerland. It is most developed in Holland, Belgium, France and those countries advanced in agriculture. In the small country of Belgium (11,373 square miles) alone there were in 1909 no less than 1,142 cattle insurance societies, comprising 101,709 members and insuring 294,583 cattle of an average value of Rs. 200 each. In addition there were 170 horse, and numerous goat and pig societies. In France in 1910 there were 8,428 cattle societies and 58 re-insurance societies. In Italy there are a very large number of societies, and federation is largely resorted to. In Germany there are over 8,400 societies, the majority of which are small local organizations.

"There is a consensus of opinion in Germany that this form of organization is the best. The members can observe and supervise the care given to insured animals, and the action taken when anything occurs, and it is to their interest to do so. They are also in a position, without incurring any appreciable expense, to estimate correctly the value of the animals both upon insurance and in case of loss. Its drawback consists in the fact that the risk is covered by too small a number of animals and in a too restricted area. Should numerous losses occur more or less simultaneously local associations may not be able to meet their obligations. It is considered advisable therefore for local societies to establish schemes of re-insurance, either by combining among themselves or by arrangements with large insurance undertakings or with the State."—(CAHILL.)

In some countries cattle insurance is State-aided and in some it is compulsory. In others the State organizes insurance by establishing institutions or federations (central societies) formed of the local mutual societies which adopt the model articles approved by the institution to which they are attached. A proportion of

the premiums received by the local societies is paid to the central society which bears the same proportion of the indemnities. In this way a wide tract of country is covered and the risks diffused.

A few years ago the Prussian Saxony Chamber introduced a system of re-insurance for the local associations in the Province. A number of these associations were formed into a union, and all with excess of receipts over expenditure had to pay the balance to the union for the purpose of covering the losses of those associations in contrary case.

Premium rates (tariffs) have to be fixed in accordance with the risks involved and the experience gained. In some cases compensation is not paid for animals lost from epidemic disease and in others certain diseases are excluded. The average mortality in Belgium in 1909 was 3·36 per cent., and the average rate of premium was 2 per cent. of the value. In that country epidemic disease is well under control and famine is unknown. In Burma, where there are some 50 societies, said to be doing well, a premium of 3 per cent. for plough cattle has been recommended, which is to be increased to at least 6 per cent. if rinderpest is included. In Bohemia the rate of premium is fixed every five years, based on the results obtained.

In most countries very young stock and old cattle are not accepted, and no indemnity is paid on insured animals that have died from the results of war, riot, rebellion, theft or loss by straying, fire, lightning, and flood. In Bohemia in the case of livestock insured for the first time the insurance only comes into force 15 days after valuation. This is a kind of quarantine to guard against disease in the incubative stage and appears to be very sound. Everywhere fraud on the part of the insuring member invalidates the insurance, and no compensation is paid if the death be clearly due to neglect.

In most cases all eligible healthy cattle of a member have to be insured and not merely a selection. This is to prevent fraud. Sickly beasts are excluded. To ensure that the owner will tend a sick animal properly and not let it die so as to obtain the insurance money, societies never pay the whole value, but a proportion,

varying from 60 to 70 per cent. Most societies fix a maximum value for which an animal may be insured. The owner states the value and this valuation is checked by the experts or committee, whose valuation holds good.

Valuations are checked every six months in some societies and altered if necessary before the half-yearly premiums are paid. In mutual insurance societies the officials give their services gratuitously but the Secretary may be paid a small sum. Every member joins for a year. After receiving any indemnity he must continue his membership for 3 years. In all cases a reserve fund is accumulated out of the balance left over after paying indemnities. When there is a reserve fund an entrance fee is usually charged to new members. Societies are always limited and therefore not responsible beyond their resources. If funds do not suffice a proportionate reduction in the indemnities is made all round.

In a few societies there is no common fund, but the owner of an insured animal is compensated when death occurs by levying a subscription on all the members to make up the value. This system is not favourably regarded by authorities on the subject of mutual insurance.

It is apparent that a system of cattle insurance by mutual co-operation in small localities is a most beneficial undertaking and not difficult of application, provided that the tariffs can be approximated to the liabilities. That desideratum has been successfully accomplished in Europe, and it remains to achieve the same result in India if possible.

THE APPLICATION OF CATTLE INSURANCE TO INDIAN CONDITIONS.

Organized co-operation in India dates from 1904, when the Government of India passed Act X of that year "to encourage thrift, self-help, and co-operation among agriculturists, artisans, and persons of limited means, and for that purpose to provide for the constitution and control of Co-operative Credit Societies." This Act only dealt with the problem of credit, but the success that was attained opened up further possibilities.

In 1912 a new Act (II of 1912) called the Co-operative Societies Act, which was more comprehensive in its application, came into existence. The new Act applies not only to Credit Societies but also to Co-operative Associations organized for purposes of distribution, production, insurance, etc. Such Associations are required to be based on co-operative principles. It is not intended that they should become close corporations for the benefit of a few individuals. The new Act recognizes the existence of central societies for the express purpose of benefiting other societies of co-operative character. Simplicity and elasticity in rules passed under the Act are aimed at. It is recognized that it is essential to start cautiously and to progress gradually. Failures discourage, and instead of teaching the people to help themselves have the contrary effect.

It may be conceded that mutual cattle insurance on sound lines is very desirable in India, and it is now necessary to study the means of applying it successfully.

The construction of any scheme of life insurance requires for its foundation as correct an estimation of the death-rate as it is possible to make. The chances of saving life by practicable methods have to be calculated at the same time. In India the absence of accurate and complete statistics in regard to the mortality of cattle complicates the situation. Epidemic disease is common and is so irregular in its incidence and in its effects that, even when statistical information is available, the prospect of an exceptionally unfavourable outbreak has to be considered and if possible provided for.

Relief in the shape of advice and treatment is the duty of the Veterinary Department. Its scope is somewhat limited at present, owing to its numerical inadequacy and the unwillingness of the more ignorant to take advantage of its assistance. Modern methods of controlling and preventing the spread of disease are not always popular, as they frequently entail individual inconvenience. There is hope for the future, however. It is the expressed policy of Government to provide more veterinary assistance gradually, and there are distinct signs that the people themselves are inclined to welcome the work of the Department. As already stated the

educative value of co-operation is a great factor in enlightenment. The Department has at its disposal the means of providing relief in many cases. In the absence of effective legislation the public spirit of individuals is looked for to enable them to be carried out. When the funds of a community or society are likely to be affected, it is expected that wholesome pressure will be brought to bear on individual members who, from prejudice or indifference, are not inclined to take advantage of measures for the public good.

It is obvious that if epidemic disease is to be included in the risks undertaken by insurance societies in India, the tariffs will usually have to be rather high as compared with countries where it is not so serious, and where in many cases compensation is given by the State. In Burma, as already stated, rinderpest is excluded as a rule. If it is included a high tariff is required.

Although many authorities are very adverse to inordinate risks being taken in any scheme of cattle insurance, the writer considers that it would be a mistake to exclude epidemic disease in India except in particular instances which will be mentioned later. Unless the risk of epidemic disease is included the benefits of insurance would be greatly minimized. Such a provision will be of real help to the people, and if successful popularize it greatly.

There are other difficulties in the way of exclusion also. If one or more diseases are excluded differences of opinion in diagnosis are bound to occur, which would probably lead to considerable friction. Even professional men are capable of making mistakes in diagnosis, and this factor might easily lead to difficulties. In India some outbreaks of epidemic disease are very mild in character and simulate death from natural causes or ordinary non-infective disease.

A short account of a few main features connected with the principal cattle diseases as they affect insurance may be useful.

The principal epidemic diseases to which cattle are liable in India are rinderpest, haemorrhagic septicæmia, anthrax, black-quarter, and foot and mouth disease.

Rinderpest is a disease which may cause extensive mortality, and as a rule attacks all the cattle in the locality that are not im-

mune. In the plains about 50 per cent. of those attacked die, and in the hills the mortality is often as much as 90 per cent. For that reason it would be unsafe to bring cattle in hilly tracts into any scheme of insurance at present. Such are not very valuable animals as a rule. Young animals die more frequently than old ones, and the mortality rate can therefore be lowered if they are excluded. Preventive inoculation can be performed in this disease. With the usual method adopted protection for a short time only is given. Early information to the Veterinary Department and the acceptance of its remedial measures will result in the death-rate in this disease being greatly reduced.

Hæmorrhagic Septicæmia is a very serious disease in some localities. It attacks buffaloes mainly. For that reason it is doubtful if these animals ought to be invariably accepted. This disease is periodical in many places and the mortality of animals attacked is usually about 90 per cent. It does not go through a herd like rinderpest, however, and draught bullocks do not appear to be very susceptible. A good deal can be done to prevent its occurrence by attention to sanitation and the provision of a clean water-supply. Preventive inoculation can be practised, but the peculiar nature of the disease in respect to its occurrence rather depreciates the practicability of the method.

Anthrax occurs in some districts, principally in the Carnatic. It is sometimes confused with the last-named disease. It is not usually seen in buffaloes. In other respects the remarks under hæmorrhagic septicæmia regarding mortality and prevention apply.

Black-quarter mainly affects young animals up to four years of age. The areas in which it occurs can usually be specified. The risk of adult animals becoming diseased may be accepted, except in notoriously bad places. Vaccination against this disease is frequently practised.

Foot and Mouth Disease causes more inconvenience than mortality.

Diseases due to external and internal parasites may be regarded as epidemic diseases also. Exceptional mortality from them is rare in adult cattle. Errors of diet, accidental poisoning, and such

like are fair risks, provided no excessive carelessness can be proved.

The risk of famine must be taken. In such an event Government assistance and private charity might be invoked justifiably.

In view of the above it is obvious that the fixation of an equitable tariff is a problem involving some difficulty. Local conditions must be carefully considered. A great deal must depend on the intelligence and foresight of the organizers. It is obvious that it would be extremely short-sighted to start a society in a locality subjected to periodical epidemics of a serious nature. It is not usual to find a good class of cattle in such places. It does not seem worth while to start a society unless the cattle are fairly valuable. The inclusion or otherwise of buffaloes is a matter for serious consideration in a locality where hæmorrhagic septicæmia occurs periodically.

It is recommended that except in special cases the risk from epidemic disease be undertaken. Should unforeseen or exceptional mortality occur in the early days of a society it would be very unfortunate, and liquidation might result. In that case a *pro-rata* distribution of funds would have to be made, and so long as this was done fairly no great harm would have been done. The remaining cattle would probably have attained a high degree of immunity, rendering them insusceptible to that particular disease at any rate. If confidence could be restored the society could be started again with that much in its favour. Every society that could tide over the first few years successfully without a serious epidemic to deplete its resources would be able to build-up a reserve fund and would then be in a strong position.

It is suggested in the model By-laws which are appended to this paper that a tariff of 5 per cent. on the value of each animal be levied. This premium is intended to cover risks from epidemic disease, subject to certain conditions mentioned in the By-laws. It is for members of societies to decide, after mature consideration in the light of their experience of the local conditions, if the rate is suitable.

It is considered advisable to limit insurance to certain classes of cattle until further experience has been gained. In India draught cattle receive most care and attention and they are most easily identified.

Immature and very old animals should be excluded. A suitable limitation of age, to commence with at any rate, is from four to twelve years.

The simplest way to age an animal of four years old is by its teeth. In India the permanent lateral incisor teeth are generally cut at about $3\frac{1}{2}$ years old and are in wear at 4 years, *i.e.*, at 4 years old the animal has 6 permanent incisor teeth and 2 milk-teeth. It is not possible to tell the age by the teeth with accuracy after 6 years old, but a rough estimate may be made. When there is any doubt about an animal being under or over 12 years it would be wise to exclude.

Some safeguard against the possibility of an indemnity having to be paid for an animal that had the seeds of disease in it at the time of examination and valuation is necessary. The model By-laws provide for this (By-law 3). They also provide for the exclusion of certain risks which no society or company ever undertakes except under special terms (By-law 4). The owner of an animal must adopt necessary prophylactic and remedial measures and legitimate pressure should be brought to bear on him if he is obstructive. To guard against dishonest practices a proportion of the value of an animal should be paid only and a maximum sum fixed. In course of time it might be possible to relax the stringency of some of the conditions.

No society should be started unless at least 100 cattle are to be insured, and there should be at least ten members. Large societies with many members are not indicated, however. It is necessary to keep down the expenses of administration, and it is very important that all insured animals should be under the eye of the society to avoid fraud. The scope of a society should be restricted to the village area therefore.

The valuation committee has most important duties to perform. The members must give their services gratuitously to keep down

expenses. When a society is confined to one village the work is not onerous. The secretary may be paid a little as he has to keep the books of the society. The success or failure of a society will depend to a great extent on the efficiency of its valuation and managing committees. When a death occurs one or more members of the valuation committee must see the carcass and give the necessary certificate. The managing committee have to supervise the decisions of the committee of experts and verify them when there is any doubt on either side. They have also to make any sanitary regulations that are necessary, and see that all insured cattle are properly looked after. If feasible, new purchases should be segregated for ten days before they are allowed to mix with the village herd to avoid the risk of epidemic disease. Itinerant cattle dealers should be obliged to keep their cattle away from villages. Their herds are frequently infected with disease and responsible for spreading it. Indemnities should be paid as soon as possible, but in the case of epidemic disease a little delay is advisable for two reasons, one being that in serious epidemics a *pro-rata* distribution of funds may be necessary, and the other, that it is better to put off the replacement of animals for some time when a village has been infected with epidemic disease.

Accounts must be kept methodically. Convenient forms will, no doubt, be prescribed by the Registrar to suit the By-laws which may finally be settled.

CONCLUSION.

It is hoped that mutual cattle insurance societies will soon be started in the Bombay Presidency.

The model By-laws which form an appendix to this paper have been drafted in collaboration with Mr. Ewbank, the Registrar of Co-operative Societies, and the Burma scheme has been freely adopted.

Any group of cattle owners desiring to form a society should first consult the Registrar or Local Honorary Organizer, who will visit the village. An informal meeting of persons owning altogether not less than 100 cattle should be called, and after making such

alterations in the model By-laws as are necessary to suit local conditions, at least 12 of them should sign two copies of the proposed By-laws and submit them to the Registrar in the form prescribed by Government. Societies should not be started unless there is a veterinary dispensary in charge of a veterinary assistant in the neighbourhood, *i.e.*, in the Taluka or within ten miles.

Eventually Central Societies will be formed, no doubt. Not less than twenty societies should be federated for this purpose. It would be advisable in this case to cover a large area, or, better still, for a proportion of societies in several detached districts to combine. In this way the financial risk attending a serious outbreak of disease or famine in any one district would be minimized. The success of mutual cattle insurance in India must obviously be somewhat problematical for the present, as it will depend so much on the fortune attending the early history of societies. Care in fixing the tariff and caution in selecting areas are strongly indicated. Every advantage should be taken of modern methods of preventing and curing disease, and great attention should be paid to the hygienic conditions under which insured animals are kept. The formation of Central Societies should eventually make for security. It is expected that progress will be slow at first, and indeed that is desirable. The experience gained by the older societies will be very valuable to the younger ones.

The small agriculturist has a lot to gain and very little to lose from a well-organized system of cattle insurance. Something will have been achieved if this paper clears the way by bringing about constructive criticism and the writer will feel that he has been amply rewarded.

APPENDIX.

MODEL BY-LAWS FOR A CO-OPERATIVE CATTLE INSURANCE SOCIETY.

1. The society shall be called The Cattle Insurance Co-operative Society, Limited. Its registered address shall be.....
2. The object of the society is to provide for its members an indemnity in case of the loss of draught cattle by death from disease or accident.

SCOPE AND CONDITIONS OF INSURANCE.

3. The society will accept for insurance healthy bullocks and male or female buffaloes between the ages of 4 and 12 years. Any animal may be admitted that has six permanent incisor teeth.

In the case of animals insured for the first time the insurance will not come into force until 10 days after valuation and registration.

4. The society will pay indemnities for the death of all animals except those dying from the following causes:—
 - (a) War, riot, and rebellion.
 - (b) Theft or loss by straying.
 - (c) Journey by railway.
 - (d) Act of a third party who is legally liable to pay compensation to owner.

(e) Contagious disease, where the member has failed to carry out any prophylactic or curative measures advised by the Veterinary Department, provided that they have been accepted by the committee and communicated to the owner by it in writing.

5. The indemnity payable shall be two-thirds of the value of the animal as fixed at the last annual valuation, subject to the provision that it shall in no case exceed Rs. 100.

6. The owner is bound to inform the committee of all cases of illness as quickly as possible, and to carry out its suggestions for treatment.

7. If the committee think veterinary assistance necessary they may call in the veterinary assistant. If they are required by the Superintendent, Civil Veterinary Department, to pay the expenses of the visit, the amount shall be borne equally by the society and the member.

MEMBERSHIP.

8. Membership of the society shall be confined to residents in the village.

9. All respectable persons, above eighteen years of age, who own plough cattle in the village are eligible for admission. The application for membership must be signed by the member and approved by a majority of the committee. An entrance fee of Re. 1 must be paid.

10. A member must continue to belong to a society at least for two years after he receives any indemnity from it, provided that he continues to own cattle in the village.

11. A member may resign his membership, with the approval of the committee, after three months' notice, provided that he has first discharged all his liabilities to the society.

12. A member may be expelled by the committee subject to appeal to the next general meeting for ill-treatment of cattle, fraud, or deceit, or breaking rules, or refusing to carry out the sanitary orders of the committee.

13. On the withdrawal or expulsion of a member any policy held by him is immediately rendered void.

VALUATION.

14. An owner wishing to insure any of his cattle shall declare the age, value, and description of the beast ; deceit in this declaration, if it misleads the valuation committee, will invalidate the insurance.

15. The value of each beast accepted for insurance shall be fixed annually by the valuation committee [appointed under By-law 34 (b)]. The age shall be fixed on admission and shall be subsequently indisputable.

16. All insured cattle shall be branded with the society's mark on the right fore foot and their description registered.

17. Animals in bad condition or of more than 12 years of age shall be refused admission, or, if already insured, re-insurance at the end of the year, provided that if any animal rejected under this rule dies within one month of the date of rejection, the owner shall receive three-fourths of the indemnity that would have been payable immediately before the rejection.

18. Animals bought to replace animals sold can be substituted, provided their value is practically the same.

19. No refund of premium is allowed if the animal insured is sold by the owner. The policy will continue in force provided that the animal is not removed from the village.

20. The valuation committee shall not value their own cattle. This shall be done by the managing committee.

FUNDS.

21. The annual premium shall be 5 per cent. of the value of animals as annually determined by the valuation committee. The premium shall be payable in advance in two half-yearly instalments, on April 1st and October 1st.

22. If any premium is overdue by more than 30 days the policy lapses and the member can get no indemnity.

23. If a member wishes to move any insured beast for more than 7 days not less than 10 miles beyond the limits of....., he is bound to inform the managing committee and to pay such enhanced premium (if any) as it may fix.

24. The funds of the society shall be :—

(1) The general fund, *i.e.*, the amount paid on account of premia during the previous and current year.

(2) The reserve fund which shall consist of :—

(a) Fines.

(b) Entrance fees and donations.

(c) Net balance for the year before last remaining over after paying all dues.

(d) Interest on any sum invested.

25. At least half of the reserve fund shall be deposited on one month's notice in the Bombay Central Co-operative Bank. The remaining funds shall be kept in the Post Office Savings Bank.

26. The reserve fund can be used for paying indemnities only with the approval of the Registrar after the general fund has been exhausted.

27. The liability of members is strictly limited to the amount of premiums payable by them under By-law 21.

INDEMNITIES.

28. The owner of a beast which has died must inform the secretary of the society of the fact of death within 24 hours. He must produce the carcass before a member of the valuation committee within 48 hours of death, and must answer truly all questions put to him.

29. The indemnity will be payable at the next quarterly meeting of the managing committee after death has been certified by the valuation committee, provided that the claim is admitted.

30. The member may dispose of the skin and carcass.

31. If the funds of the society (both reserve fund and general fund) are exhausted, indemnities for all deaths during the quarter must be proportionately reduced.

THE GENERAL MEETING.

32. At the commencement of each year (April 1st) a general meeting shall be held. Its duties shall be :—

- (a) To elect a managing committee of seven members.
- (b) To elect a valuation committee of three expert members.
- (c) To receive the balance sheets of the previous year as prepared by the managing committee, and to pass them.
- (d) To consider the audit note and any communication received from the Registrar or any suggestions made by members.
- (e) To hear and to dispose of appeals.
- (f) To appoint a secretary and to fix his pay and bonus (if any).

THE MANAGING COMMITTEE.

33. The Managing Committee of seven members, of which three are a quorum, shall perform the following duties:—

- (a) To hear and decide appeals from decisions of the valuation committee.
- (b) To elect its own chairman, whose services shall be gratuitous.
- (c) To supervise the treatment of the animals insured.
- (d) To make sanitary rules which shall be binding on the members and to fine members sums not exceeding Re. 1 for infringements.
- (e) To check the accounts, and to see that no defaults in the payment of premia are allowed.
- (f) To authorize the secretary to pay indemnities after considering claims.
- (g) Generally to carry on the business of the society.

34. The managing committee shall meet at least once a quarter.

DISPUTES.

35. Disputes between the society and a member shall be settled by arbitration, the arbitrator being appointed by the Auditor of Co-operative Societies in charge of the society. The decision of the arbitrator shall be final and not removable in any Court of Law.

Signatures.

SOME OBSERVATIONS ON UPPER BURMA PADDY (GROWN UNDER IRRIGATION).

BY

E. THOMPSTONE, B.Sc.,

Deputy Director of Agriculture, Northern Circle, Burma.

Introductory.

IT is now six years since classification of, and experiments on, Upper Burma paddies were commenced on the Mandalay Experimental Station ; and it is over four years since improvement, chiefly by selection, of some of these paddies was begun.

A rough botanical classification was issued in the form of a Bulletin in 1911 after which classification work was discontinued for a time. But later it was deemed by the Provincial Agricultural Conference, at the instigation of the Agricultural Chemist, to be of considerable importance, and in consequence the work was resumed on slightly different lines. An economic classification of all the principal varieties is in progress, and the Assistant Botanist has made such headway that it is hoped that in a short time it will be brought to a satisfactory conclusion. This classification is based on those important agricultural and botanical characters which underlie the problems of rice improvement and of increase in yield ; and at the present time if any particular type of paddy is required, for improvement, selection, or any other purpose, it can be obtained by reference to the standard collection, the name of the variety, and the locality from which it was originally collected.

An account of the experiments and also an abbreviated statement of some of the selection work may be found in the Mandalay Farm Reports.

During the course of this classification, experimental and improvement work, many difficulties and problems were met with—difficulties which, at that time, had not been overcome by any work published by any of the Agricultural Departments in India. Consequently in the absence of an Agricultural Botanist an attempt was made to solve some of them for ourselves as far as compatible with the work on hand. The observations set forth below have therefore been the results of work which, though of secondary importance, was none the less essential to progress. Though the writer does not lay claim to finality in his conclusions, the observations have been carefully made and some of them have already proved to be extremely helpful in carrying out the principal tasks now engaging attention.

Results such as those obtained by the Economic Botanist, Bengal,¹ have gone far to solve some of the problems. Yet it is hoped it will not be superfluous to include in this note observations obtained in a different way and almost entirely before this publication appeared. Those figures which may be on the same lines as any which have been already published will at least strengthen the conclusions arrived at.

Some of the principal problems of paddy cultivation in Burma have been set forth by the Deputy Director of Agriculture, Southern Circle, Burma,² and they are to all intents and purposes the same for Upper as for Lower Burma—except that owing to different conditions some of them are probably even more accentuated in the former area. There is, therefore, little need to detail them here or to call attention to the many difficulties which beset the person who attempts to solve these problems. It must, however, be remembered that the conditions under which paddy is grown in Upper and Lower Burma differ. In the former the conditions are dry and irrigation is in most places resorted to, whilst in the latter

¹ Hector, G. P. "Notes on Pollination and Cross-fertilization in the common Rice plant, *Oryza sativa*, Linn." *Mem. Dept. of Agri. in India, Bot. Series*, Vol. VI, No. 1, June, 1913.

² McKerral, A. "Some Problems of Rice Improvement in Burma." *Agri. Journal of India*, Vol. VIII, Pt. IV, October, 1913.

country the rainfall is very heavy—sufficient for the crops, and the atmosphere during the growing season almost always very full of moisture. Whether this will make a difference in the general behaviour of the plant remains to be seen. It certainly makes a difference in the variety most suitable; for in Upper Burma those varieties which generally succeed best in the irrigated areas are seldom the most successful in an entirely rain-fed tract and *vice versa*. The soil also, apart from the water-supply, not only determines the variety but, according to the cultivator, the time and method of planting.

There are four practically distinct crops of paddy, divided and named according to the season of growth, *viz.* :—

I. *Kaukyin* (sometimes called *Kauksaw* or *Kauklat*) or early paddy sown about the month of June, *i.e.*, very early in the rains, and harvested in October. This is often called autumn rice.

II. *Kaukgyi* sown July to September and harvested from early December to end of January. This, sometimes called "Winter rice," is the main or principal crop, occupying about ninety-five per cent. (more than nine and a half million acres) of the total area under paddy in Burma and forming the principal, almost the only, source of export paddy and rice.

It is on this crop grown under irrigation that the observations herein recorded have for the most part been made.

III. *Mayin* paddy is sown in December and January and reaped in May and June.

IV. *Kaukti* paddy is sown (usually broadcast) about the end of March or during April and reaped in June or July. The *Kaukti* crop is of least importance.

These two crops, *Mayin* and *Kaukti*, are almost always of the "Kaukkyan" or non-glutinous varieties of rice. They are the principal crops grown round the edges of *Ins* or lakes and other places where they are planted, or quite commonly sown broadcast, in fields as the water recedes or dries up during the hot weather. The *Mayin* crop is of considerable importance covering an area of nearly 90,000 acres.

Many varieties of paddy are capable of growing quite well either as *Kaukyin* or as *Kaukgyi*; but only very few are found to succeed both as a *Kaukgyi* and as a *Mayin* paddy.

In the first two classes, *Kaukyin* and *Kaukgyi*, are to be found both glutinous (*Kaukkyin*) and non-glutinous (*Kaukkyan*) rices, with grades of semi-glutinous rices between. The non-glutinous varieties are, however, by far the most important as well as the most numerous; and it is with varieties of non-glutinous *Kaukgyi* that almost all this work has so far been carried out.

The Improvement of the Race.

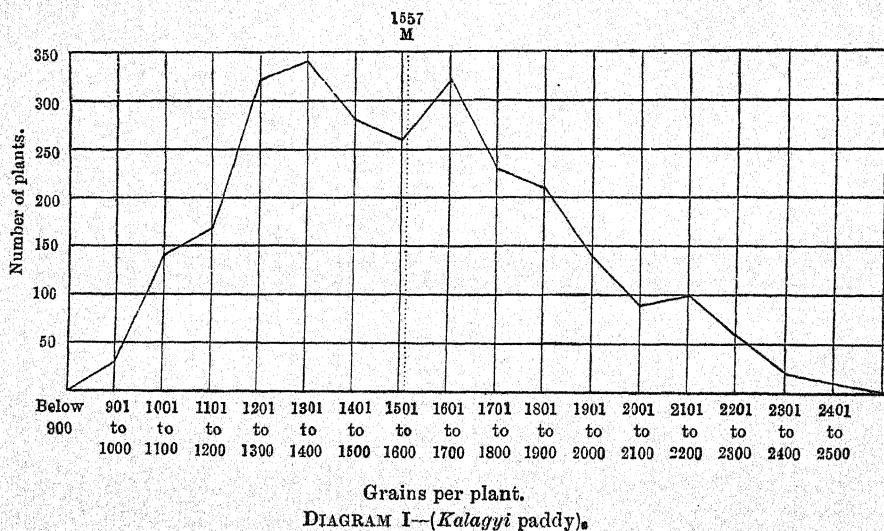
The work of plant improvement being carried on at the present time is largely based on the now almost universally accepted principle that in the ordinary field of any farm crop there exists an indefinite number of "elementary species" which, when isolated and grown separately, are found to breed true so long as they are kept free from external contamination. Practically every cultivator's field of paddy in Upper Burma contains a mixture of two or more varieties (and generally also many hybrids) which can readily be observed and selected. There is no need to grow them separately to show that they are of different varieties. But if one of these varieties, consisting of individuals of similar external appearance, be grown it can by a little experiment and some tedious work be proved that, like Johannsen's beans, the variety is composed of a number of elementary species or strains, and that by selecting the best "pure line" an improvement in the race can quite readily be effected.

The characters of plants dealt with are concerned chiefly with yield and the laws governing yield—these, owing to the condition of the rice trade and the consequent indifference of millers towards quality, being of primary importance. So long as the miller obtains fairly clean sample of bold grain of regular size and shape free from admixtures of awned and red grains he is quite satisfied and is unwilling to pay for any improvements in quality. In fact good and bad paddy frequently obtain the same market

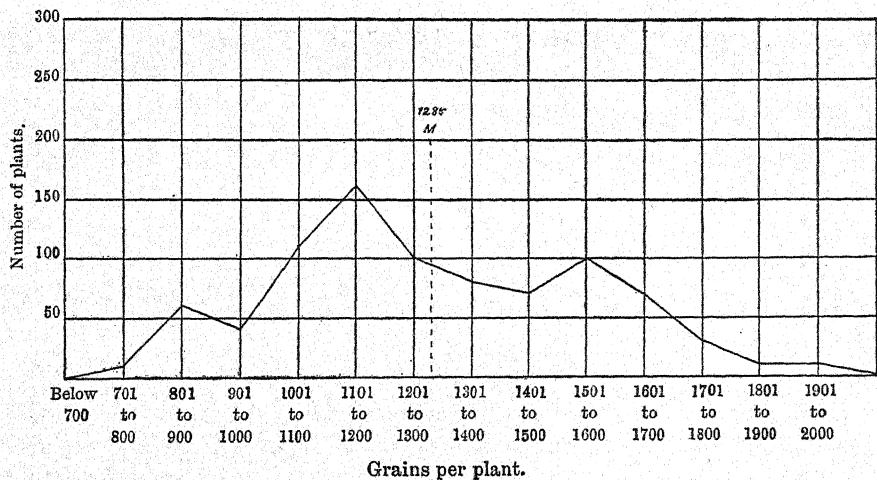
rates, the only difference being that due to "poundage"—an allowance made according to the weight per basket. Hence there is little wonder that the cultivator has an eye to crop outturns only. The question of quality has, therefore, received scant consideration here, and the improvement in yield of those strains conforming to the trade requirements given above has been the writer's chief aim.

Of the observations made the following three are most easily reduced to the form of frequency curves and will serve to show that even where varieties are not mixed plants vary considerably and are susceptible of improvement by selection. They also throw some light on the inheritance of yielding power in some strains of paddy.

1. *The number of grains per plant.*—Two of the purest cultivator's varieties of paddy obtainable were taken for selection purposes and the seed (previously hand-selected) was sown in the ordinary way. The plants were transplanted singly at one foot apart each way and the number of seeds produced by many of the plants was counted. In the case of *Kalagyi* paddy, diagram I. represents the result of 2,720 countings. In diagram II. the result of counting the seed produced by 840 plants of *Ngasein-gyi* is depicted.



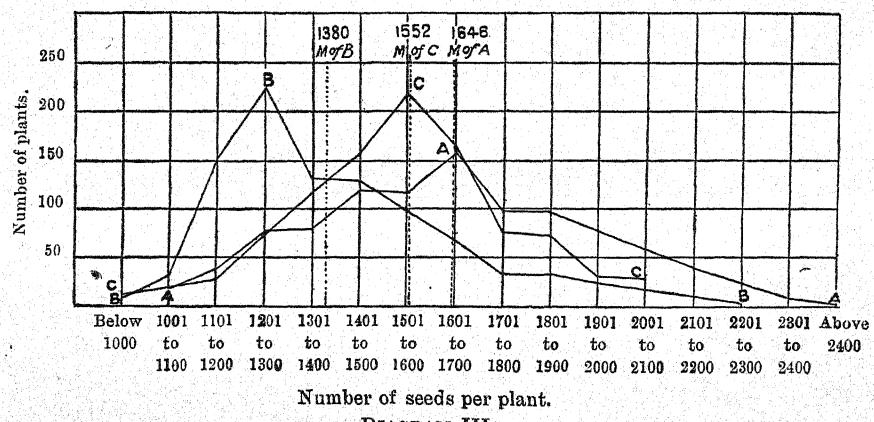
Grains per plant.
DIAGRAM I.—(*Kalagyi* paddy).

DIAGRAM II—(*Ngaseingyi* paddy).

The curves are somewhat flat owing to the small number of countings made and to the narrowness of the groups. By making groups of 200 instead of 100 seeds the curves become very much steeper. They, however, serve their purpose in showing where the "mode" or highest frequency of each of the varieties lies—that of *Kalagy*i at 1,300-1,400 grains per plant and that of *Ngaseingyi* at 1,100-1,200 grains per plant—and also in showing the range of variation. Ordinary *Kalagy*i paddy produces from 900 to 2,500 seeds per plant and ordinary *Ngasein* from 700 to 2,000 seeds. The mode indicates the *prevailing type* of grain and is of great importance especially to the breeder who wants to produce grain having any particular characteristics or to the man who is endeavouring to "fix a type." Such breeders will select with reference to the prevailing type, but what we are most interested in, as breeders of high-yielding paddy, is not the mode or the range of variation, but the average production of the whole population of plants, that is the "mean" (marked M) or arithmetical average. It can be seen approximately where this lies by looking at the diagrams. In diagram I. it lies a little above 1,500 grains per plant (actually 1,557) and in diagram II. between 1,250 and 1,300 grains per plant (actually 1,285). To obtain the mean accurately we multiply each value by its *frequency*, add the results, and then divide the sum

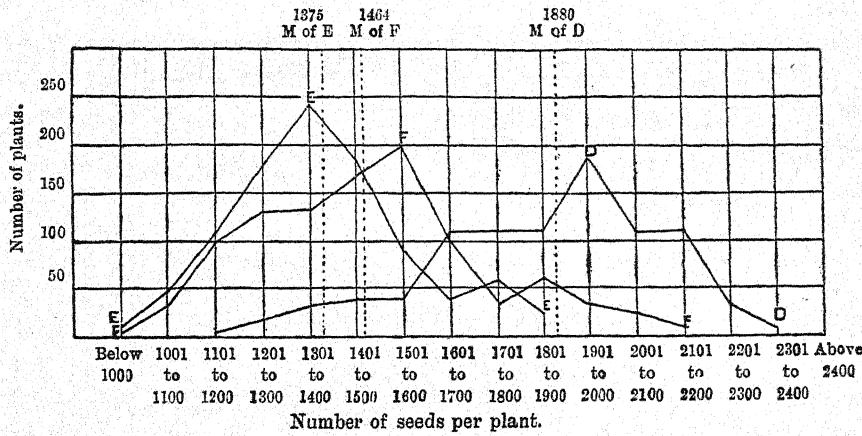
by the number of individuals, or as they are called "variates." For the purpose of this paper, however, the approximate "means" are sufficient, and it may be unnecessary in every case to go through the long calculations required to secure the accurate figures. From the mean a very good conception is obtained of the *average type* of paddy under consideration so far as this particular character is concerned, and it is this type which is of greatest importance to us.

Let us now see what takes place when line breeding is carried out. A number of single plant selections were made and sown and planted in the same way the following year. It was not possible to make a very large number of countings as should have been done to obtain more accurate data, but the six pure lines (A to F) of *Kalagyi* depicted in diagrams III and IV are representative of those data which were taken. They are drawn to the same scale as diagram I for comparison and in consequence of the smaller number of variates (about 1,000 only in each case) the curves appear somewhat flat. As, in making selections of plants for breeding purposes, the worst were carefully avoided, it is quite probable that the differences could have been more accentuated by including in our pure lines some of the poorer specimens. They are, however, sufficiently pronounced to illustrate the variability or deviation of the pure lines from the original type and from one another.



Number of seeds per plant.

DIAGRAM III.



Compare these diagrams with diagram I. In diagram III, the mean of the plants of pure line A falls between 1,600 and 1,700 (actually at 1,646) and this is somewhat higher than the mean of the original (diagram I). The mean of the plants of line B, on the other hand, falls between 1,300 and 1,400 (actually at 1,380) which is much lower than that of the original, and the mean of the plants of line C falls at 1,552 which is almost identical with that of the original paddy. Turning to diagram IV, the mean of the plants in pure line D falls at 1,880, that of the plants of line E at 1,375, and that of those of line F at 1,464. These means are respectively much higher, much lower, and slightly lower than the mean of this original paddy mixture.

These results very closely conform to those obtained by weight from the variety testing plots.

*Table of comparison.
(In order of "Mean.")*

| Paddy. | Mean of seeds per plant. | Yield per acre. (Average of 5 trials.) |
|-------------------------|--------------------------|---|
| Line E | 1,375 | 3,754 lbs. |
| " B | 1,380 | 3,708 " |
| " F | 1,464 | 3,820 " |
| " C | 1,552 | 4,053 " |
| Ordinary hand-selected. | 1,557 | 3,925 " |
| Line A | 1,646 | 4,063 " |
| " D | 1,880 | 4,493 " |

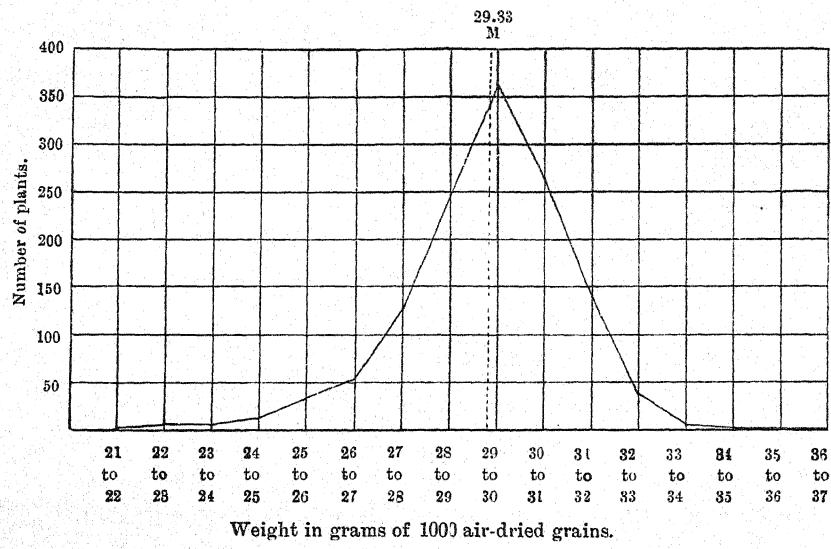
*Badly affected with 'Gwabo.'

The slight irregularity in increase in yield is due to "Gwabo," *i.e.*, the presence of empty glumes (mentioned later in this paper), the reason for which is not yet well understood. The percentage of empty grains due to this cause was taken and those numbers marked with an asterisk in the above table were all badly affected and the yield by weight thereby reduced. It was noted that those lines which contained most "Gwabo" in 1912-13 also contained most in the 1913-14 crop. This indicates a predisposition to the "disease," and if this be proved it will be necessary to take it into account in selection work.

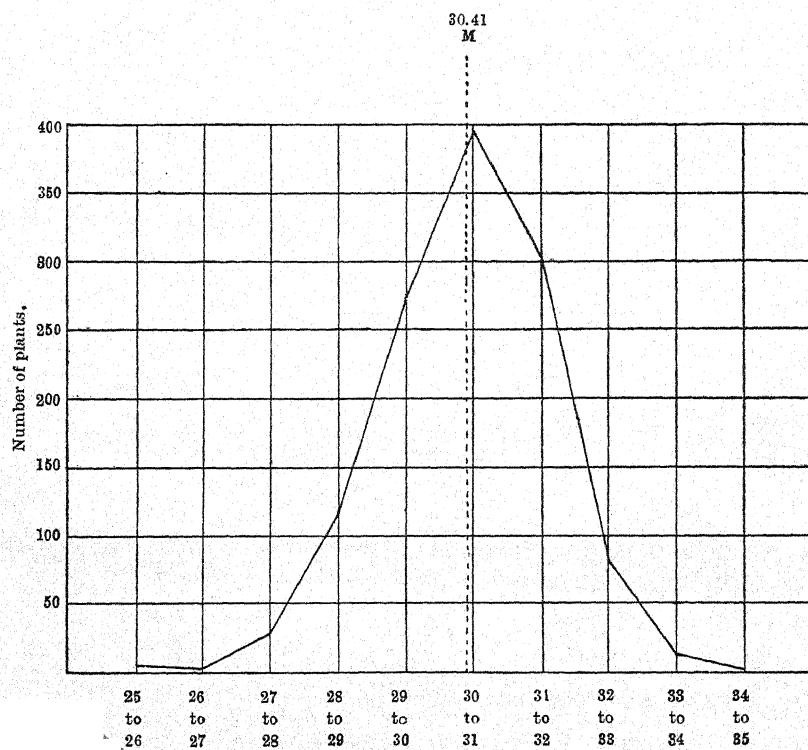
After three years' trials (the last year repeated four times) pure line D (Field No. 1009) turned out to be one of the best races and was selected for the seed farms. Its actual yield is nearly 15 per cent. (or allowing for experimental error, about 12 per cent.) above that of ordinary hand-selected *Kalagy*i. In the case of some other varieties selected in the same way we have obtained increases in yield of 25 to 30 per cent. As, however, they still remain in the selection plots to be further proved they are not given here. The other plants graphically presented here, being little or no improvement on the original, were discarded.

Similar graphs have resulted from the counting of seeds of other varieties and also by weighing the seed; but in the latter case owing to the prevalence of "Gwabo" which causes empty glumes, the results were in some cases irregular. Hence the weight of grain is not always as accurate an indication of yielding capacity as the number of seeds per plant, from which, taken along with the weight of a definite number of seeds, a good idea can be obtained of the merits of a pure line at an earlier stage than can be done from variety testing in the field only.

II. *Variations in weight of grain.*—That there is a considerable variation in the weight of the grain from different plants is shown by data giving the weight of 1,000 air-dried grains of 1,293 different plants of *Kalagy*i and 1,212 different plants of *Ngaseingyi*. The plants were not selected but taken at random from even fields of ordinary grain. Diseased and obviously "light" seeds were rejected when counting.



Weight in grams of 1000 air-dried grains.

DIAGRAM V—(*Kalagyi*).

Weight in grams of 1000 air-dried grains.

DIAGRAM VI—(*Ngaseingyi*).

Diagrams V and VI show the results of *Kalagy*i and *Ngaseingyi*, respectively. The former variety has a range of variation from 21 to 37 grams with a mean weight of 29.3 grams, whilst the latter varies from 25 to 35 grams and has a mean weight of 30.4 grams. Though the grain of the two varieties is practically of the same size (from actual measurements taken *Kalagy*i appears to have a very slightly larger grain) owing to the thickness of the glumes in *Kalagy*i, *Ngasein* is the heavier grain. This is actually found to be the case in well cleaned market samples, a "basket" of the latter variety being 2 or 3 lbs. heavier than one of the former.

Plant to plant weighments were not made for the pure lines but the average weights taken from 5 separate weighings of 1,000 grains of each pure line show a considerable variation though, owing to the rigid selection carried out and to the small numbers of pure lines involved, the range of variation was not so great as in the original. The weights of 1,000 grains of the *Kalagy*i lines varied from 30.3 grams to 32.03 grams whilst those of the *Ngasein* lines varied from 30.4 grams to 32.5 grams. The fact that none of these falls below the mean of the original not only shows a part of the effect of selection, but indicates that the production of heavy-weight grain, though no doubt influenced by soil and other conditions, is hereditary and consequently that the weight of the grain can be improved by selection. The yielders of the heaviest weight of grain per acre do not by any means always produce the heaviest seed, and so far these two desirable qualities have not been found combined in the same plant to the extent that one could wish.

III. *Tillering*.—There is perhaps little need to dwell long upon the fact that tillering varies with the variety, the soil, and the treatment of the plants. In classifying the numerous varieties of paddy grown in Upper Burma several hundred samples were received and grown and under these conditions (irrigation on a second class soil) the average number of tillers produced was found to vary from four to as high as twenty-five.

Generally speaking there appears to be a relationship between the length of life of a paddy and the number of tillers produced.

UPPER BURMA IRRIGATED PADDY

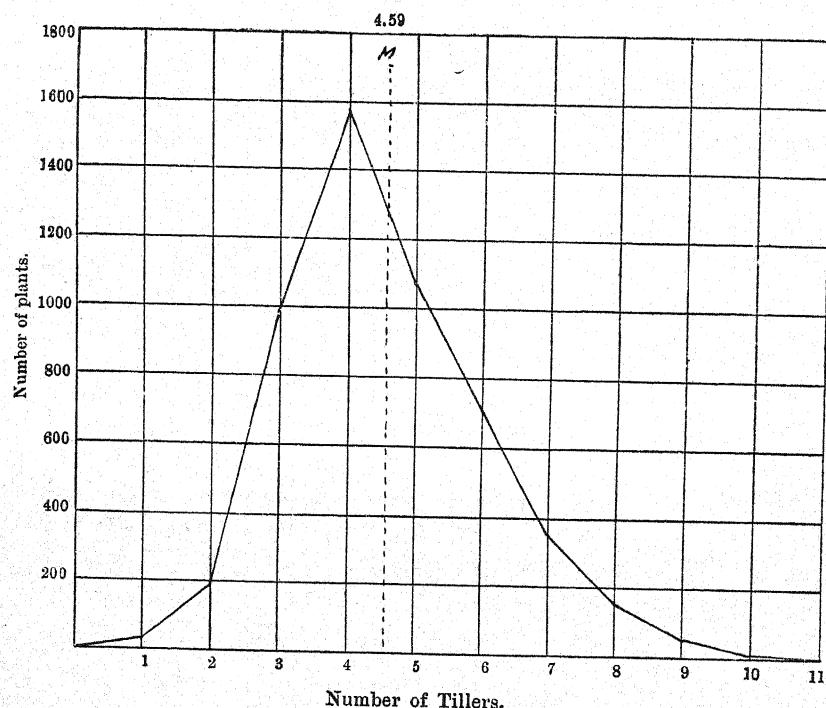
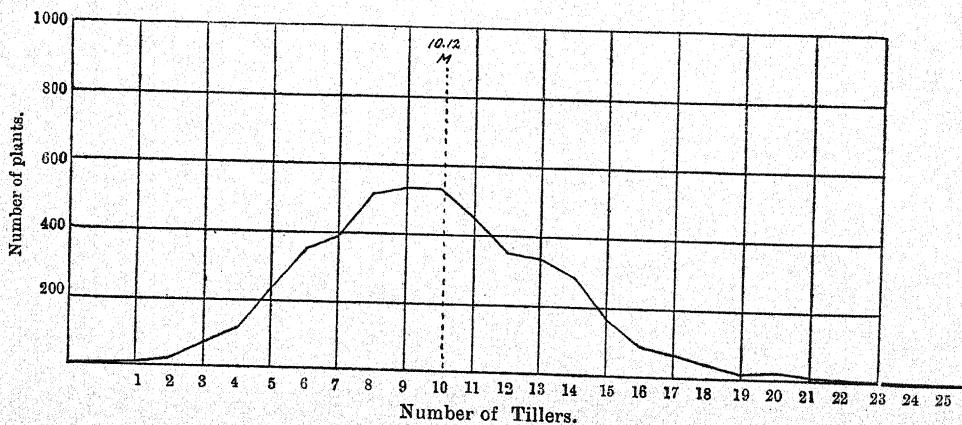
The *Kaukhnyins* are generally short-lived paddies, ripening in about 140 to 160 days, and these produce comparatively few tillers; whilst the *Kaukkyans* which are generally longer-lived varieties tiller much more freely.

The following Table gives a comparison of two varieties which though producing grain of similar appearance are very dissimilar in habits. The countings are all made from single plants transplanted 1 foot apart each way.

TABLE I.

| Number of Tillers. | Number of plants of | |
|--------------------|--|---|
| | (1) <i>Kalagyи</i> (a 150 day variety). | (2) <i>Ngaseingyi</i> (a 170 day variety). |
| 1 | 28 | 10 |
| 2 | 190 | 22 |
| 3 | 988 | 72 |
| 4 | 1,568 | 118 |
| 5 | 1,065 | 236 |
| 6 | 705 | 344 |
| 7 | 346 | 386 |
| 8 | 154 | 508 |
| 9 | 58 | 532 |
| 10 | 11 | 526 |
| 11 | 4 | 446 |
| 12 | | 358 |
| 13 | .. | 338 |
| 14 | .. | 284 |
| 15 | .. | 170 |
| 16 | .. | 98 |
| 17 | .. | 72 |
| 18 | .. | 42 |
| 19 | .. | 20 |
| 20 | .. | 24 |
| 21 | .. | 14 |
| 22 | .. | 2 |
| 23 | .. | 2 |
| 24 | .. | 1 |
| 27 | .. | 1 |

It will be noticed that No. 1 has its mode or highest frequency at 4 tillers and has a comparatively short range, whilst No. 2 has its mode at 9 tillers and shows a much longer range of variation. The tillering of these two varieties may then be represented graphically as in diagrams VII and VIII.

DIAGRAM VII—(1) *Kalagyi* variety.DIAGRAM VIII—(2) *Ngaseingyi* variety.

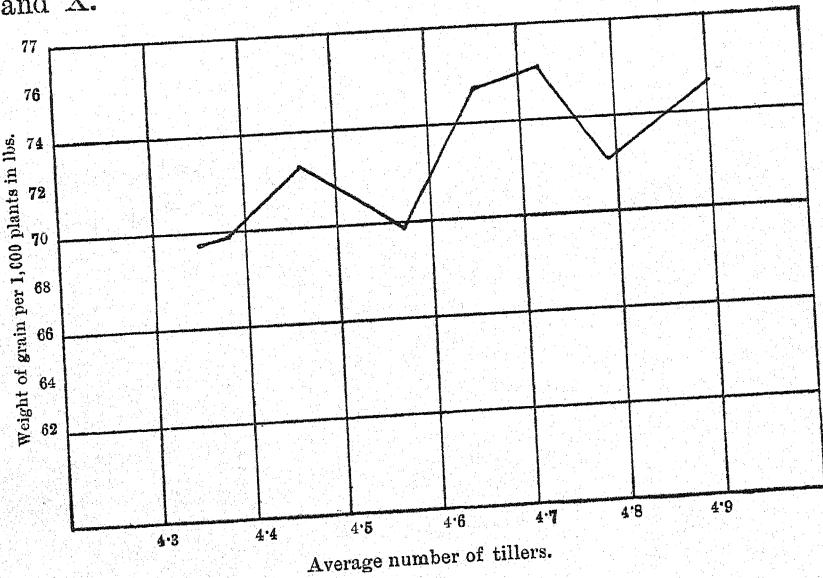
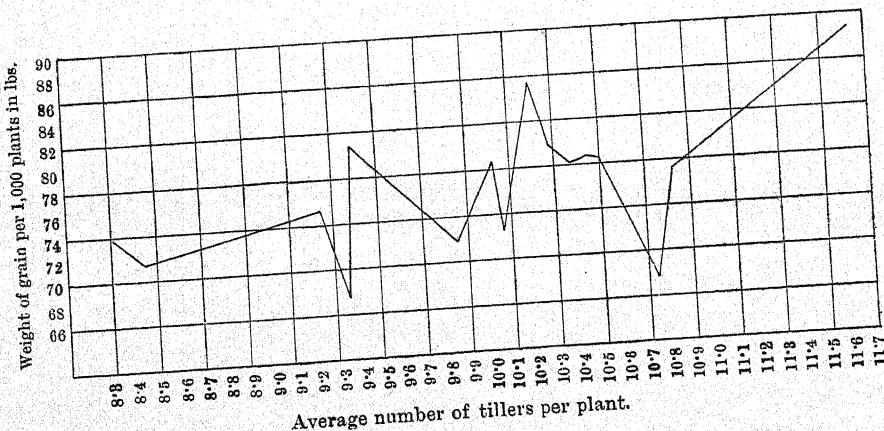
For *Kalagyi* the mean or "average type" is found to fall at 4.59 tillers per plant, whilst that of *Ngaseingyi* occurs much higher at 10.12.

Of the pure lines of *Kalagyi* only nine were counted and the mean of each was calculated. Five of these means fell slightly

UPPER BURMA IRRIGATED PADDY

below the average type of the variety and the remainder gave values above that of the type. In the case of *Ngasein* there were nine above and eight below the value of the average type. With two exceptions, however, in neither case was any striking increase in the number of tillers secured.

To ascertain whether the yield is proportional to the number of tillers observations were made on a number of pure lines of the same two varieties with the results shown in diagrams IX and X.

DIAGRAM IX—(*Kalagyi*).DIAGRAM X—(*Ngaseingyi*).

These graphs show that, speaking generally, as the tillers increase there is an increase in the weight of grain ; but this increase is not in *direct* proportion to the number of tillers produced by the plant. In other words as the number of tillers increases the average yield per tiller decreases. Moreover the very irregular line indicates that it by no means follows that because a plant has many shoots it is the best to select in breeding high yielding strains. One is sometimes apt to select a plant with numerous tillers without due reference to the number or weight of grains borne by each shoot. Up to the present time the highest yielding strains have been found among those whose "mean" for tillering is but a little higher than that of the original type ; whilst some of the strains with a high tillering mean have yielded by weight but comparatively poor outturns of grain—the "lines" producing high tillering averages yield comparatively small and light panicles. It is quite possible that this may be due in some degree to the restriction of the space allowed for each plant or to the soil. For a plant of many tillers to produce its maximum yield a wide or rich feeding ground must be provided.

A planting distance has been maintained at 1 foot each way for all varieties and this appears to give very good results for work of comparison, but, in the case of free-tillering strains which do not show an increase of grain in direct proportion to the number of tillers, an increase of space might result in a better outturn. If this be so the space which, theoretically, ought to be given to each plant will depend upon the hereditary mean tillering power of the strain.

A Table is given below showing roughly the Burman cultivator's idea of the distance apart of transplanting and number of seedlings in relation to soil and season. It is the result of many enquiries and the averages of many measurements taken.

No doubt the custom of reducing the distance or increasing the number of seedlings according to the condition of poverty of the soil and to lateness of transplanting has been formed by generations of experience, but at the same time one can meet many cultivators who have a very shrewd idea of the reasons for these practices.

TABLE II.

| Class of Soil. | APPROXIMATE PERIODS OF TRANSPLANTING. | | | | |
|-------------------|--|--------------------------------|----------------------------------|--|--|
| | 12th July to 30th July | 31st July to 16th August | 17th August to 30th August | 31st Aug. to 15th Sept. | 16th Sept. to 29th Sept. |
| | A. | B. | C. | D. | E. |
| 1 First class .. | 3 to 4 seedlings 11" apart | 3 to 4 seedlings 9" apart | 3 to 4 seedlings 7" apart | 3 to 4 seedlings 5" apart | 3 to 4 seedlings $4\frac{1}{2}$ " apart |
| 2 Second class .. | 3 to 4 seedlings $9\frac{1}{2}$ " apart | 3 to 4 seedlings 7" apart | 4 to 5 seedlings 5" apart | 4 to 5 seedlings $4\frac{1}{2}$ " apart | 4 to 5 seedlings $3\frac{1}{2}$ " apart |
| 3 Third class .. | 3 to 4 seedlings 6" apart | 4 to 5 seedlings 5" apart | 4 to 5 seedlings 4" apart | 4 to 5 seedlings 4" apart | 5 to 6 seedlings $3\frac{1}{2}$ " apart |

That the kind or condition of the soil affects the tillering has been often observed, but the data are not sufficiently complete for reproduction. This district contains, in addition to the dark clay soil which can be readily and well puddled, several soils of a lighter and drier nature. On such soils the extent of tillering is very poor and in consequence the cultivator plants more closely. The observations on tillering on these soils have been made with three common local varieties, *viz.*, *Kalagy*, *Ngasein*, and *Taungtaikpan*; but whether the variations are due to differences in texture, fertility, or water-supply has not been determined. The effect of increased fertility may be seen from the increase in the average number of tillers due to manuring in the table of results given below. The figures were obtained from a new manurial series started in 1913, and manured once only. Each plot has its own unmanured control plot alongside and each carried the same number of plants transplanted one foot apart each way.

TABLE III.

| No. | Manurial Treatment per plot of $\frac{1}{20}$ th acre. | Average number of tillers in | | Difference. | Increase or Decrease. |
|-----|--|------------------------------|---------------|-------------|-----------------------|
| | | Manured Plots. | Control Plot. | | |
| 1 | Farmyard manure 133 lbs. (30 lbs. N. per acre). | 9.06 | 8.17 | 0.89 | Increase. |
| 2 | Farmyard manure 221 lbs. (50 lbs. N. per acre). | 8.54 | 8.01 | 0.53 | Do. |
| 3 | Farmyard manure 310 lbs. (70 lbs. N. per acre). | 9.34 | 8.12 | 1.22 | Do. |
| 4 | Cotton cake 85½ lbs. (50 lbs. N. per acre). | 10.07 | 8.69 | 1.38 | Do. |
| 5 | Farmyard manure 133 lbs., Superphosphate 7.3 lbs. (30 lbs. N., 20 P_2O_5 per acre). | 10.73 | 8.62 | 2.11 | Do. |
| 7 | Farmyard manure 133 lbs., Bone Phosphate 2½ lbs. (30 lbs. N., 20 P_2O_5 per acre). | 8.64 | 7.13 | 1.51 | Do. |
| 8 | Bone Phosphate 2½ lbs. (20 lbs. P_2O_5 per acre). | 8.18 | 6.83 | 1.35 | Do. |
| 9 | Superphosphate 7.3 lbs. (20 lbs. P_2O_5 per acre). | 6.22 | 4.54 | 1.68 | Do. |
| 10 | Potassium Sulphate 2 lbs. (20 lbs. K_2O per acre). | 5.37 | 5.38 | 0.01 | Decrease. |
| 11 | Nitrate of Soda 9.2 lbs. (30 lbs. N. per acre). | 5.65 | 4.66 | 0.99 | Increase. |
| 12 | Nitrate of Soda 9.2 lbs. (30 lbs. N. per acre). | 7.34 | 6.28 | 1.06 | Do. |
| 13 | Ammonium Sulphate 7.6 lbs. (30 lbs. N. per acre). | 6.95 | 5.70 | 1.25 | Do. |
| 14 | Nitrolime 8.2 lbs. (30 lbs. N. per acre). | 7.23 | 5.31 | 1.92 | Do. |
| 15 | Slaked lime 100 lbs. (2,000 lbs. per acre). | 5.11 | 5.65 | 0.54 | Decrease. |
| 16 | Bone Sulphate 7.6 lbs., Superphosphate 7.3 lbs., Potassium Sulphate 2 lbs. (30 lbs. N., 20 lbs. P_2O_5 , 20 lbs. K_2O per acre). | 8.55 | 5.13 | 3.42 | Increase. |
| 17 | Burnt paddy husk 600 lbs. | 6.48 | 6.39 | 0.09 | Do. |
| 18 | Ni7 | 4.61 | 4.64 | 0.03 | |

Organic manures and some of the chemical manures, *e.g.*, ammonium sulphate, appear to have a marked effect upon the tillering.

The number of tillers produced per plant varies (up to a certain point) directly according to the space allowed in transplanting. From a large number of single-plant transplanting experimental results, the following averages have been calculated for one variety:—

UPPER BURMA IRRIGATED PADDY

TABLE IV.

| Distance apart of Transplanting. | Space per plant in square inches. | Average number of Tillers per plant. | Average weight of grain per 100 plants in Ozs. |
|----------------------------------|--------------------------------------|--|---|
| 4" × 4" | 16 | 2.1 | 10.9 |
| 6" × 6" | 36 | 3.0 | 10.7 |
| 8" × 8" | 64 | 4.2 | 29.1 |
| 9" × 9" | 81 | 3.9 | 29.4 |
| 10" × 10" | 100 | 4.3 | 32.3 |
| 12" × 12" | 144 | 5.4 | 38.7 |
| 15" × 15" | 225 | 7.7 | 67.9 |
| Unlimited space | .. | Up to 27 | .. |

Diagram XI represents these results in a graphic form.

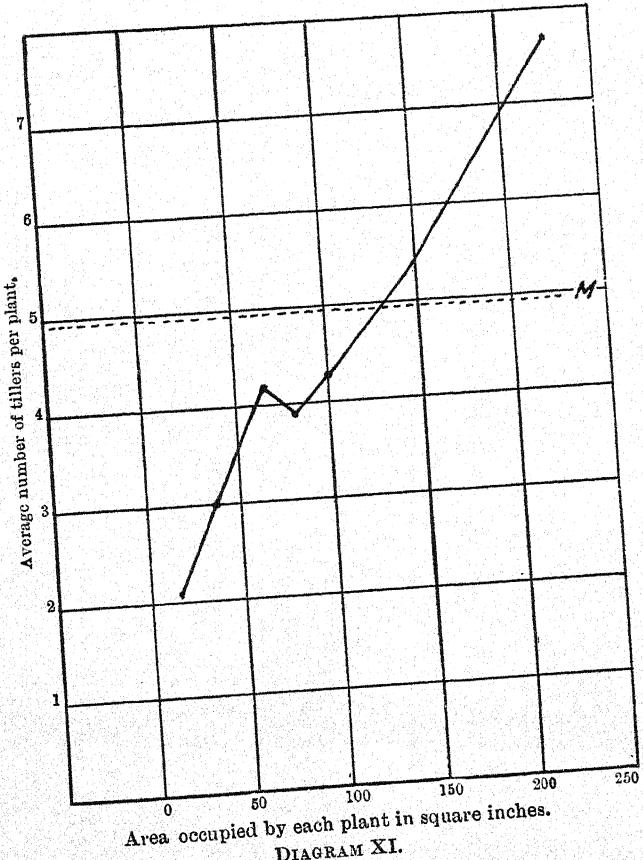


DIAGRAM XI.

Similar results have been obtained for some other varieties, but it is unnecessary to reproduce more of them here.

In group planting it was found that though the best yields were obtained by planting "doubles," the average number of shoots arising from each pit varied as the number of transplants, but not in direct proportion.

| Number of plants per group or pit. | Average number of Tillers. |
|------------------------------------|----------------------------|
| 1 | 3.30 |
| 2 | 3.75 |
| 3 | 5.30 |
| 4 | 5.60 |

This result is not in accord with those reported from Madras Presidency and as it was obtained from a comparatively small number of countings further data will be collected.

As opposed to the planting of a number of seedlings in one pit it was found that a well grown plant can, after it has produced tillers, be divided a number of times and that division and retransplanting appear to stimulate tillering.

On Cross-fertilization and Heredity.

The results given below have been obtained only in connection with the line-breeding method of plant improvement begun in 1910, and the materials made use of in preparing this note were originally gathered as subsidiary observations in connection with the more important work on hand. Previous to that time (1910), it had been repeatedly proved to the writer that plants producing red grains frequently make their appearance in crops of white-grained varieties, considerably reducing the value of the produce and causing a great deal of trouble to the cultivators; many of whom, in their own way, frequently make repeated efforts to get rid of such undesirable plants. The method not infrequently adopted is hand-selection of sufficient good heads for seed purposes; but, while this no doubt tended to improve the produce, it seldom had the desired effect in the succeeding crop of eliminating red grain, the reappearance of which is accounted for by the cultivators in various ways. Whilst most of their theories are of a superstitious nature pertaining to "Nats" or other supernatural beliefs, the writer has frequently

been told that the cause is cross-fertilization regarding which many observant Burmans are by no means ignorant.

Among a number of single plant selections of *Ngasein* paddy were found four plants, which, although in external appearance exactly like ordinary *Ngasein*, produced all red grain. In 1911 the produce of each of these plants was planted in rows of single plants 1 foot apart. In two plots, the produce of plants labelled B and X there were found to be four different kinds of plants as shown below; but in the other plots the plants all came true to the type sown, so far as the characters under observation were concerned.

TABLE V.
Result of Plots B and X.

| Description of Plant. | | | | | | Number of Plants. |
|-------------------------------|----|----|----|----|----|-------------------|
| (a) White glumes, red grain | .. | .. | .. | .. | .. | 239 |
| (b) Red glumes, red grain | .. | .. | .. | .. | .. | 75 |
| (c) White glumes, white grain | .. | .. | .. | .. | .. | 73 |
| (d) Red glumes, white grain | .. | .. | .. | .. | .. | 27 |
| | | | | | | 414 |

This gives 314 red-grained plants and 100 white-grained plants; also 312 white-glumed plants and 102 red-glumed ones. The proportions of these are $3\cdot14 : 1$ and $3\cdot1 : 1$, respectively.

The conclusions drawn from these figures have since been to a large extent proved by other writers.¹

(1) That plants B and X were natural hybrids or heterozygous plants of some previous natural cross-fertilization.

(2) That whiteness and redness of glumes act as a pair of simple Mendelian characters, the former being dominant.

(3) That whiteness and redness of grain also act as a pair of simple Mendelian characters, redness being dominant.

(a) Hector, G. P. *loc. cit.*

(b) McKerral, A. *loc. cit.*

The recessive colour of the glumes was a deep rusty red whilst the dominant colour was a dull white or very pale yellow.

These pairs of characters were by no means the only variants, but they were the only ones for which numerical observations were taken.

In the following year the produce of each of the different classes was again sown to see what happened. A measure of about 200 seeds from each plant was sown in nurseries separately and thinly and the transplants were planted singly at no definite but at a good distance apart, so as to facilitate examination of each plant. Unfortunately it was not possible to deal with all the seed of each plant or to take account of any characters other than those observed on the previous occasion.

From (a) (see Table V above), that is the produce of plants having, like the original hybrid, white glumes and red grain there were grown 239 plots each from the seed of a single plant. Every plant was examined with the result given in the Table below.

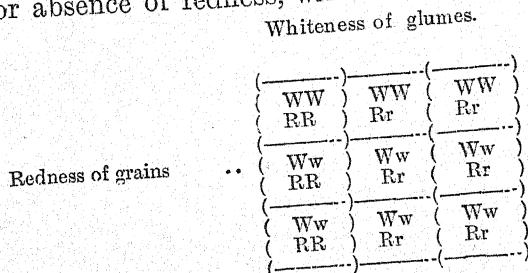
TABLE VI.
Result of (a) plots.

| No. | Description of plants. | Number of plots. | Number of plants having :- | | | |
|-----|--|------------------|----------------------------|--------------|-------------|--------------|
| | | | White Glumes. | | Red Glumes. | |
| | | | Red grain. | White grain. | Red grain. | White grain. |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I | All plants with white glumes and red grain .. | 26 | 2,198 | .. | .. | .. |
| II | All plants with white glumes but grain of some plants red and of some white .. | 55 | 3,124 | 1,010 | .. | .. |
| III | All plants with red grain but glumes of some plants white and of some red .. | 57 | 2,801 | .. | 932 | .. |
| IV | Plots a complete mixture as obtained in the previous year .. | 101 | 5,236 | 1,673 | 1,728 | 577 |
| | TOTAL .. | 239 | 13,359 | 2,683 | 2,660 | 577 |

The significance of the above results is easy to see. In No. I the parent plants were all homozygous for both characters. In No. II they were homozygous for glume colour, but heterozygous for colour of grain, whilst in No. III they were homozygous in respect of grain colour, but heterozygous for colour of glumes. In No. IV the plants were heterozygous for both characters.

The numbers obtained may now be examined. As already shown (Table V) in the F_2 generation, the proportion of white-glumed to red-glumed plants was approximately 3 : 1, and if splitting is taking place in Mendelian proportions, one of the three white-glumed plants will be homozygous. Similarly in the 3 : 1 proportion of red-grained to white-grained plants, one of the three will be homozygous and the other two heterozygous for that character. Hence, among the 239 plants of (a) there should be one-third (or $239/3$) homozygous white-glumed, and the same number of homozygous red-grained plants, but the probability of these characters being combined in the same plant is only $\frac{1}{3}$ of $\frac{1}{3}$ i.e., 1/9.

A glance at the following diagram, where W stands for whiteness of glume, w for absence of this character, R for redness of grain, and r for absence of redness, will make this clear.



WW and RR are combined in only one plant out of nine; though there are WW and RR each in two other plants, the remaining four plants being heterozygous for both characters. The actual proportion of plots obtained (see Table VI) was 1 : 2.11 : 2.26 : 3.81 (i.e., 1 WW RR to 2.11 WW Rr to 2.26 Ww RR to 3.81 Ww Rr); that is almost as might be expected 1 : 2 : 2 : 4. In considering these figures one must bear in mind the small number of plots involved.

The recessive colour of the glumes was a deep rusty red whilst the dominant colour was a dull white or very pale yellow.

These pairs of characters were by no means the only variants, but they were the only ones for which numerical observations were taken.

In the following year the produce of each of the different classes was again sown to see what happened. A measure of about 200 seeds from each plant was sown in nurseries separately and thinly and the transplants were planted singly at no definite but at a good distance apart, so as to facilitate examination of each plant. Unfortunately it was not possible to deal with all the seed of each plant or to take account of any characters other than those observed on the previous occasion.

From (a) (see Table V above), that is the produce of plants having, like the original hybrid, white glumes and red grain there were grown 239 plots each from the seed of a single plant. Every plant was examined with the result given in the Table below.

TABLE VI.

Result of (a) plots.

| No. | Description of plants. | Number of plots. | Number of plants having :- | | | |
|-----|---|------------------|----------------------------|--------------|-------------|--------------|
| | | | White Glumes. | | Red Glumes. | |
| | | | Red grain. | White grain. | Red grain. | White grain. |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I | All plants with white glumes and red grain | 26 | 2,198 | .. | .. | .. |
| II | All plants with white glumes but grain of some plants red and of some white | 55 | 3,124 | 1,010 | .. | .. |
| III | All plants with red grain but glumes of some plants white and of some red .. | 57 | 2,801 | .. | 932 | .. |
| IV | Plots a complete mixture as obtained in the previous year .. | 101 | 5,236 | 1,673 | 1,728 | 577 |
| | TOTAL .. | 239 | 13,359 | 2,683 | 2,660 | 577 |

The significance of the above results is easy to see. In No. I the parent plants were all homozygous for both characters. In No. II they were homozygous for glume colour, but heterozygous for colour of grain, whilst in No. III they were homozygous in respect of grain colour, but heterozygous for colour of glumes. In No. IV the plants were heterozygous for both characters.

The numbers obtained may now be examined. As already shown (Table V) in the F_2 generation, the proportion of white-glumed to red-glumed plants was approximately 3 : 1, and if splitting is taking place in Mendelian proportions, one of the three white-glumed plants will be homozygous. Similarly in the 3 : 1 proportion of red-grained to white-grained plants, one of the three will be homozygous and the other two heterozygous for that character. Hence, among the 239 plants of (a) there should be one-third (or 239/3) homozygous white-glumed, and the same number of homozygous red-grained plants, but the probability of these characters being combined in the same plant is only $\frac{1}{3}$ of $\frac{1}{3}$ i.e., 1/9.

A glance at the following diagram, where W stands for whiteness of glume, w for absence of this character, R for redness of grain, and r for absence of redness, will make this clear.

Whiteness of glumes.

| | | | | |
|-------------------|----|------|----|------|
| Redness of grains | .. | (WW) | WW | (WW) |
| | .. | (RR) | Rr | (Rr) |
| | .. | (Ww) | Ww | (Ww) |
| | .. | (RR) | Rr | (Rr) |
| | .. | (Ww) | Ww | (Ww) |
| | .. | (RR) | Rr | (Rr) |

WW and RR are combined in only one plant out of nine; though there are WW and RR each in two other plants, the remaining four plants being heterozygous for both characters. The actual proportion of plots obtained (see Table VI) was 1 : 2.11 : 2.26 : 3.81 (i.e., 1 WW RR to 2.11 WW Rr to 2.26 Ww RR to 3.81 Ww Rr); that is almost as might be expected 1 : 2 : 2 : 4. In considering these figures one must bear in mind the small number of plots involved.

Now in reference to the numbers of plants in the plots No. II, the proportion of red to white-grained plants is 3·09 : 1 and the proportion of white-glumed to red-glumed plants is almost exactly 3 : 1. In plots No. IV the proportions of white-glumed to red-glumed plants (6,909 to 2,305) and red-grained to white-grained plants (6,964 to 2,250) are respectively 2·99 : 1 and 3·09 : 1.

There now remain to be considered the results obtained by sowing (b), (c), and (d) of Table V, but as these are much more simple than those of (a) they will be included in one statement. As in the case of (a), a quantity of seed of each plant was sown and transplanted separately; and every successful plant of the produce was examined for the characters under observation.

TABLE VII.

| Plots marked (Table V). | Description of Parent Plants. | Total Plots. | Number of plots pure, i.e., producing only plants like parent (b). | Plants in pure plots. | Impure plots giving mixed produce. | Number of plants in impure plots having | | | |
|-------------------------|-------------------------------|--------------|--|-----------------------|------------------------------------|---|------------|--------------|------------|
| | | | | | | White glumes. | | Red glumes. | |
| | | | | | | White grain. | Red grain. | White grain. | Red grain. |
| (b) | Red glumes, red grain .. | 75 | 26 plots | 4847 | 49 | .. | 5* | 1827 | 5660 |
| (c) | White glumes, white grain .. | 73 | 27 .. | 4223 | 46 | 6586 | 16* | 2227 | .. |
| (d) | Red glumes, white grain .. | 27 | 27 .. | 4816 | .. | .. | .. | .. | 3* |

The numbers in the above table marked with an asterisk are not easy to explain. The plants occurred singly, or, in not more than two or three, in any plot of 100 to 200 plants and the only explanation that can be given is that they are accidental mixtures possibly from dropped seed of the previous year's crop.

From plants marked (b) were obtained 26 plots which are pure for both characters and 49 the parent plants of which were homozygous for red-glume colour but heterozygous for grain colour, the proportion of red to white-grained plants being 3·09 : 1.

UPPER BURMA IRRIGATED PADDY

From (c) we obtained 27 plots which may be regarded as pure for both characters and 46 which proved to be homozygous for grain colour, which is white, but heterozygous for colour of glume. The proportion of white-glumed plants to red-glumed plants, in the latter plots, is 2·95 : 1.

From (d) we obtained nothing but plants having red glumes and white grain. Hence the parent plants were pure for both of these two characters.

Apart from glume and grain colour a great variety of forms were obtained especially as regards size and shape of grain, but, as already explained, numerical calculations could not be undertaken. Specimens of some of these forms have, however, been retained for educational purposes and at the same time a few apparently exceptionally prolific plants derived from these hybrids have been selected for field trial purposes.

In another and independent experiment carried out in 1913 an Assistant obtained the following results from 11 plants of the F₂ generation:—

TABLE VIII.

| Plant No. | Plants with red grain. | Plants with white grain. |
|-----------|------------------------|--------------------------|
| 1 | 28 | 60 |
| 2 | 37 | 76 |
| 3 | 26 | 66 |
| 4 | 20 | 69 |
| 5 | 17 | 91 |
| 6 | 33 | 64 |
| 7 | 19 | 75 |
| 8 | 33 | 80 |
| 9 | 18 | 81 |
| 10 | 21 | 77 |
| 11 | 16 | 84 |
| | 268 | 823 |

The proportion bears out the results obtained above and those obtained by the other writers already mentioned.

Pollination, Natural Cross-fertilization, etc.

In the *Monthly Bulletin of Agricultural Intelligence and Plant Diseases*, Rome, for June 1913, page 894, there is given a summary

of the report of observations and experiments conducted by Rudolfo Farneti, in *Atti dell' Istituto Botanico dell' Universita di Pavia*. In this summary it is stated "that the pales of rice never open, before, during, or after the dehiscence of the anthers. Consequently the natural production of hybrids is impossible even as a chance occurrence." However true this may be for Southern Europe, it is certainly incorrect as applied to Burma. In the dry districts of Upper Burma hybrids are quite common among the numerous "rogues" to be found in nearly every field of ordinary paddy, and Mr. McKerral has shown that they are not difficult to find in the wet zone of Lower Burma. Of the red "rogues" selected from a field of white paddy 22 per cent. were found by him to split up—proving that they were heterozygous. It is difficult to see how this condition of things could have arisen except by mixtures or close growing of red and white-grained plants and subsequent natural cross-fertilization.

With the assistance of Mr. Sawyer, Assistant Botanist, the writer has from year to year examined a very large number of plants of many varieties of *Kaukgyi* at the time of flowering and has found that the following observations hold good in every case :—

(i) As the heads of paddy emerge from the sheath the flowers mature from above downwards, before, or when very little spreading of the panicle has taken place. The stamens emerge daily generally from segment of the head which has just come out of the sheath and the head ripens the whole of its flowers in 3 or 4 stages on successive mornings.

(ii) The glumes open, the stamens hang out, and the feathery stigmas protrude once only and for a short time in the early morning—usually between 7 and 10 A.M. Dewy mornings appear to be most favourable, and "flowering" will then be at its maximum height about 8 to 9 A.M. As the dew gradually disappears the flowers will be found to be opening rapidly but, as soon as the day begins to get very bright, dry, and warm, no more glumes open and those already opened close up again—the stamens by this time being dried and shrivelled up.

(iii) The angle formed by the two edges of the glumes when the flowers are fully open is about 25 to 30 degrees, but the stamens have often emerged before the flower is fully open.

(iv) Pollination takes place before the glumes open, or at the moment of opening—seldom afterwards. At the moment they emerge from the glumes the anthers are found to be already open at the lower end, and with the aid of a microscope, pollen grains can generally be found on the stigmas.

From a few flowers allowed to open naturally as the anthers were on the point of emerging (or as far as possible just before they emerged) they were nipped off and the flowers covered up. The fruits of all these that were uninjured by the process developed normally. On the other hand, of those which were opened artificially and the anthers removed before flower was ready to open and afterwards left without covering, about 5 per cent. developed normal fruits (actually 11 out of 208). This may, however, have been due, partly at least, to the great difficulty experienced in opening unripe flowers without injuring them.

The stiffness of the glumes and the manner in which they "hook" together make artificial cross-fertilization difficult. It is not easy to open the flower without damaging the glumes so that one or other of them shrivels up, but a little success was attained by first running a fine needle between the two glumes on each side so as to unhook them and then carefully opening the glumes but a short distance to remove the stamens.

One other point in connection with fertilization and the prevalence of "Gwabo" may be worth mentioning here.

"Gwabo" is the Burmese name given to that condition of paddy which causes empty husk without any grain enclosed. In some parts of Burma and in some seasons "Gwabo" is very prevalent—the writer has seen samples threshed with twelve to fifteen per cent. of empty husk. Although it is known that whole heads of unfilled grain may be the result of boring grubs (*Schoenobius bipunctifer*, etc.) which are fairly common in some parts and that, as shown

by Dr. Butler,¹ the fungus *Sclerotium Oryzae* may be the cause of considerable losses yet these are not what is generally referred to as "Gwabo" nor can they be made to account for more than a small portion of the damage, which amounts to many lakhs of rupees annually. The presence of the borer grub is easily seen and the work of the fungus is not difficult to identify. The real "Gwabo" as mentioned here is that condition where the sterile grains are not found in whole heads or even in masses on one head but scattered throughout the panicle among the sound grains. The grains near the rachis are more generally affected than those on the ends of the branches. The ears are not discoloured; and there is no late tillering or development of green sterile shoots or discoloration of lower internodes to indicate the presence of the fungus. The husk is completely empty (except for the shrivelled stamens and ovary). It contains no badly developed grain as is sometimes the case after the work of the insect and the fungus—there does not appear to have been any attempt at development.

Since Dr. Butler's investigation took place in 1912 the present writer has tried unsuccessfully in several ways to find out the cause of this condition which results in such an enormous loss to the country and is rapidly being converted to the idea that it is caused by some external physical agency. It appears to be quite possible that conditions of climate and atmospheric moisture may have some effect upon the fertilization of the ovules. Many intelligent Burman cultivators maintain that heavy rainfall at the time of flowering is the cause of this sterility and consequently after a season which is very wet at the time paddy is flowering "Gwabo" is prevalent. This is in accord with Hector's² statement that "If the weather is wet and rainy at the time when the flowers should normally open....., they may not open at all or, if they do, they often do not close again and a large percentage of such flowers set no grain." Other cultivators state that excessive

¹ "Diseases of Rice," Bulletin No. 34, Agricultural Research Institute, Pusa, pages 34-36.

² "Notes on Pollination and Cross-fertilization in the common Rice plant, *Oryza Sativa*, Linn." Mem. of the Dept. of Agr. in India, Bot. Series, Volume VI, No. 1, page 4.

irrigation has the same effect, whilst still others have similar theories connected with the wind.

No evidence can at present be found indicating that there is a greater proportion of empty husks in those varieties flowering here during the rains than in those flowering during the dry weather. In fact observations point in the other direction, *viz.*, that the *Kaukgyi* crop—flowering in November-December—suffers the greatest proportion of loss. If, as is generally believed, climatic conditions do modify pollination or its effects the above appears to indicate that the varieties which habitually flower during the rainy season are in some way adapted for this purpose; but the *Kaukgyi* varieties, not being so adapted, when a wet spell occurs at the time of flowering, are unable to effect fertilization of all the flowers. If such be the case or if weather conditions are responsible the chances of finding a remedy and so reducing the enormous losses which occur in the main crop are very remote. The investigation of “Gwabo” is still being continued.

SUGAR PRODUCTION IN THE UNITED PRO- VINCES, FROM AN ENGINEER'S POINT OF VIEW.

BY

WILLIAM HULME,
Sugar Engineer Expert.

IT will be viewed with some concern by those responsible for the development of the agricultural resources of India that the importation of sugar is steadily increasing. This will readily be seen by comparing the following import statistics obtained from the India Office, London :—

| | 1903-4. | 1912-13. | 1913-14. |
|------------|-----------|------------|------------|
| Cwts. | 6,333,843 | 15,443,033 | 17,937,390 |
| £ | 3,957,183 | 9,519,172 | 9,971,200 |

shewing an increase in ten years of 11,603,547 cwts. of the value of £6,014,017, the increase for last year over the previous year alone being 2,494,357 cwts.

Of the sugar imported into India three-fourths comes from Java, and the question naturally arises why this should be so. The reasons for this commanding position of Java in the sugar-world probably are :—

- (1) Efficiency of the staffs controlling the factories.
- (2) The installation of the best machinery in the factories.
- (3) Intensive cultivation.
- (4) Climatic conditions and the geographical position of the island.

It will be admitted that the first three factors are applicable to any sugar-producing country, but the fourth requisite enforces the fact that the *climatic conditions* of Java are more suitable than

those of the United Provinces for the cultivation of the sugar-cane, and this certainly gives Java an advantage, the exact extent of which cannot at present be accurately estimated. But on the other hand the *geographical position* of the United Provinces has some compensating advantages. It is said that it costs Java Rs. 37·8 per ton to get her sugar into the United Provinces. If this is so, it is a considerable tax on Java sugar brought to the United Provinces and other markets north and west of this sugar-producing region. It is thus quite possible that the advantages obtained from the climatic conditions of Java over the United Provinces are cancelled by the exorbitant cost of transport.

It will be interesting to watch the development of the new sugar factory which has been recently erected in the Gorakhpur district. It is said to be the intention of the proprietors to raise the efficiency of the factory to the same standard as that in vogue in Java factories. If this is done, and a sufficient supply of good fresh cane is maintained during the season, satisfactory results may be confidently anticipated.

It is unfortunate that the cultivation of cane in India is done on scattered areas, as this causes delays and difficulties to factories capable of crushing from 8,000 to 12,000 maunds of cane per diem. It is well-known that rapid deterioration of the sugar-cane occurs after cutting, hence if there is any delay between cutting and crushing much loss is caused to the factory; it is therefore imperative to exercise skilful and strenuous supervision in regulating the cutting of the cane at the proper time and ensuring delivery with the least possible delay.

At present the factory owners are in most cases compelled to buy the cane in small lots from numerous cultivators, who are eager to get the matured cane off their land in order to prepare it for other crops, and in their eagerness frequently attempt to deliver more cane per day than the quantity arranged for. The result of this procedure is that the factory owners must either refuse to take the cane, which would be disastrous to the cultivator or crush stale cane at a loss to themselves.

The duration of the "campaign" is of great importance to the factory owners, and where practicable it would be advantageous for them to acquire sufficient land adjacent to each factory to grow about one-third of the cane required by that particular factory during a season. This would enable them to cultivate both early and late-ripening varieties of cane, so as to extend the season to the utmost. An extension of twenty days would increase the season's output twenty per cent., without appreciably increasing the establishment charges. Other advantages would also accrue if high-class cultivation were adopted on the factory plantation. To mention only one, the local cultivator would be induced to improve his cultivation, and thereby get, per acre, more cane of richer and better quality.

The quantity produced per acre is very important in these days of keen competition, and has become a factor which cannot be neglected. The selection of suitable land and its irrigation are of the highest importance, and in any scheme for the production of sugar on a large scale and to compete with foreign markets they must be carefully considered.

The Agricultural Department is working on the selection of varieties and the cultivation of sugar-cane in various districts, and good results may be expected in due course.

For the efficient control of a modern factory it is necessary to employ a highly technical staff of trained men, comprising a manager with a general knowledge of the business, a chief engineer with an assistant, both of whom must have been trained in sugar machinery, a chemist who has specialized in the chemistry of sugar and sugar-cane, and trained sugar-boilers or pan-men. As the salaries of such a staff would be considerable items in the establishment charges, and the depreciation on the expensive machinery is necessarily high, and in view of the fact that the campaign lasts only 100 days, it is essential that the factory should work continuously during the whole of that period. Therefore the staff must be energetic and resourceful, and well able to cope with any difficulties that may arise.

A factory dealing with 12,000 maunds of cane per day would pay better than one crushing 8,000 maunds. There are many factories in other countries crushing 15,000 maunds per day, but in the United Provinces it would be difficult to centralize so much cane unless the owners acquired a considerable area of land near the factory and adopted modern appliances for the quick conveyance of the cane from the fields to the factory.

The smaller the factory the more difficult it becomes to make it pay. The same skilled staff is necessary for a small modern factory as for a large one, and as the duration of the campaign is only 100 days, the comparatively small turn-over is heavily taxed to pay the wages of the permanent skilled staff (who are practically idle for 265 days in the year), the interest on capital, and a fair amount for depreciation.

It is suggested that if some other business were combined with the smaller-sized factories so as to utilize some of the machinery and the idle skilled staff, then the smaller-sized modern sugar-factories crushing, say, about 1,500 maunds of cane per day would have a better chance of success.

In looking around for a suitable adjunct to a small sugar-factory it would appear that as plenty of oil-seeds are grown locally, a seed-crushing and oil-extracting plant might be adopted with some prospect of success. There appears to be a fair market for oil of most kinds locally, and the meal from the seeds could be mixed with the molasses from the sugar-factory, compressed into cake or cakettes, and sold for feeding horses and cattle when ordinary fodder is scarce.

A huge business is done in England and France in feeding stuffs, the seeds for which are carried from India and other countries and the molasses from America and the West Indies, and judging by the rapid growth of the business in recent years it is reasonable to assume that considerable profits are made. In the United Provinces the materials (oil-seeds and molasses) are on the spot, and the nucleus of a seed-crushing plant, consisting of the existing boilers and engines, pumps, tanks, water-supply, offices and an intelligent staff, is already installed in the sugar-factory. The

processes of seed-crushing, oil-extracting, and even oil-refining are simple ; and a little training would suffice to make the staff efficient, whilst the additional cost of a seed-crushing and oil-refining plant when compared with the cost of a sugar factory is very low.

It is suggested to start the seed-crushing plant when the sugar season is over and to run it for about 200 days. This arrangement would afford the staff a rest of about two months in the year, and during that time the boilers and engines could be inspected and, if necessary, repaired.

The seeds available for crushing in the United Provinces are rape, linseed, gingelly, castor, ground-nuts, mustard, and cotton, some of which are very rich in oil.

The market for oil is assured, and there is also a fair market for oil-cake and other feeding-stuff.

It is probable that a seed-crushing and oil-extracting plant will be installed by the proprietors of a certain modern sugar factory in the United Provinces in the near future. If it proves to be a success there will be better prospects for the success of small modern sugar factories.

The improvement of the indigenous methods of sugar production in the United Provinces has been under consideration for some time. At first sight this would appear to be an easy thing to do, but there are obstacles in the way. In modern factories there are multiple-mills weighing 700 tons, whilst in India most of the crushing is done by bullock-mill that a strong man can lift. These bullock-mills are usually fitted with three rollers, two of 10" by 8", and one smaller for regulating the feeding of the mill. They are arranged to work in a vertical position, at a peripheral speed of about six feet per minute, and the average extraction of sucrose by such mills is about 50 per cent., as against about 90 per cent., in a modern multiple-mill.

Crushing sugar-cane is no longer work for bullocks, and as long as it continues so will the importation of sugar increase.

As nearly all the cane in India is crushed by bullock-mills, it is impossible to expect any increase in extraction from that source.

The bullocks at the commencement of the crushing-season are generally worn and weary, and very often the mills are "slackened off" to enable the weak bullock to rotate the mills which naturally reduces the extraction and causes much loss to the cultivator, who is usually too poor to buy stronger bullocks even if such were available.

To improve the extraction more power is required, the cultivator has not got it, and cannot get it.

Any scheme to improve the indigenous methods of the production of sugar must include power-driven mills, which are costly and beyond the purchasing power of the ordinary cultivator. It is possible that a number of cultivators in co-operation with the *khandsaris* could purchase a power-mill, and the question arises as to what kind of motive power would be the most suitable. Steam-power appears to be the best because the megass, supplemented by a little fuel, could be used for generating steam, also the exhaust steam for heating the juice, and the waste heat from the boiler for evaporating.

Of course the owners would have to conform to the Boiler and Prime-movers' Acts (these Acts may keep many enterprising people from taking up mechanical power), and employ a certified man.

What kind of a power-mill would be the most suitable?

A good single three-roller mill at its best, with United Provinces cane, would, at a speed of 18 feet (peripheral), extract about 65 per cent., a double-mill (six rollers) would extract about 75 per cent., and a triple-mill with crusher would extract about 90 per cent. Therefore if the suggested co-operative company could raise the money, the triple-mill would give the best results; but if the money could not be raised the double-mill could be reduced in speed, and an extraction of about 80 per cent. obtained.

Then as to the size of the mill. 270 maunds of cane per day (about 80 acres of cane in 100 days) would be small enough to warrant the capital outlay, and a reasonable turn-over to meet depreciation and the expense of a skilled man (Indian).

It is not to be expected that this small factory would be able to make sugar to compete with foreign sugar ; but it would supply sugar or *gur*, such as is now made by country factories for consumption by orthodox Indians, and for which higher prices are paid (although, most of it is very impure) than for factory-made sugar.

The objects of such a factory would be to reduce the loss in extraction at present made by the bullock-mill, and the losses due to inversion and caramelization ; the heat for boiling purposes would be under control, and the losses due to over-heating, which are considerable at present, would be reduced to a minimum.

It would also greatly help the industry if the *khandsaris* undertook the crushing of the cane by steam-power and relieved the cultivators from that work. At present in Bareilly District they buy the juice from the cultivators and boil it into *rab* which is afterwards centrifuged, the molasses taken off is boiled again and a second sugar is made. Then the sugar is put through a grinding and bleaching process which is certainly ingenious, but at the same time very objectionable, for it is taken outside into the sun on to a square patch of ground which has been levelled and covered in some instances with a layer of concrete, and sometimes with a layer of cow-dung which is beaten down to form a hard surface. Strips of thin cotton-cloth are laid down, and the sugar is placed on the cloths in long and low narrow ridges, from about 12" to 15" at the base and 6" or 7" high. Trained men stand barefooted on the top of each ridge and by a peculiar twist and side movement of the ankle and foot gently grind the sugar, moving along the ridges in this fashion from end to end many times. Another coolie follows turning over the sugar and casting it up from the sides to the top of the ridges. The work of the foot-grinder is laborious, and must be done in the glare of the sun on account of the bleaching action of its rays. Consequently the men perspire, the sugar sticks to their feet, and is from time to time scraped off and carefully returned to the ridges.

This sugar fetches very high prices, very often Rs. 3 per maund, more than is paid for high-class factory-sugar of high purity. It

is difficult to find out whether this fancy price is paid for the imparted flavour, or on account of prejudice against modern factory-made sugar ; probably it is the latter.

It is gratifying to note that there is evidence of this prejudice gradually weakening. The sugar made at the modern factory at Pilibhit owned by Raja Lalta Prasad and Sahu Hari Prasad is nearly all sold to orthodox Hindus. The Raja and his brother invite all and sundry to visit their factory, so that they may see that there is nothing used in the process which would be objectionable to the most orthodox.

Probably one cause of the increasing importation of foreign sugar into India is that the sweetmeat-maker finds it more profitable to mix foreign with Indian sugar. When he clarifies Indian sugar some of the weight is lost in taking off the scums from the impure sugar, as well as the cost of the re-agents that he uses (tar-taric acid, etc.). Most of the foreign sugar is much purer than the Indian sugar and is cheaper. He cannot use all foreign sugar because the public demands the molasses flavour present in the Indian sugar, therefore he mixes the Indian and foreign sugars and produces better-looking sweets.

It is highly probable that there will be a large demand for *gur* for many years to come, and it is recognised by the Government of the United Provinces that something might be done to improve the general conditions of *gur*-making, and in some degree reduce the losses due (1) to low extraction of juice from the cane, (2) to overheating the juice, causing caramelization, and (3) to inversion caused by acidity of the juice. To this end a series of experiments will be carried out on a Government Farm near Bareilly.

A small but powerful multiple-mill has been erected near Bareilly, by means of which, it is expected, useful data may be obtained regarding the advantages of maceration. When the extraction of juice from the cane is very high, sap juices are expressed, and these require special treatment necessitating the employment of a chemist. The salary of a chemist would be a burden upon a very small factory, and with this in view experiments will be made to find out the limit of extraction in order not to express

the sap juices, and to find out some simpler way of treating the juices than is practised to-day in modern factories.

It is a long stride from the country bullock-mill to the multiple power-mill, but the adoption of the latter seems to be the only way to stop the enormous losses which cannot be avoided while the small country-mill is rotated by worn and weary bullocks.

By the adoption of multiple-mills the extraction would be improved about 30 per cent. This increase of thirty per cent. on the sugar (which is said to be 3,000,000 tons), produced by the country methods in India, would amount to 900,000 tons at £10 per ton; that is a saving of £9,000,000 or Rs. 13,50,00,000. Some saving could be looked for also in connection with the treatment of the juices.

We are bound to recognize the fact that climatic conditions are not as favourable to the growth of sugarcane in the United Provinces as they are in Java, our principal competitor; and this fact in itself is a strong reason why the losses in extraction and manufacture should be brought down to a minimum.

The writer hopes the forthcoming experiments will help in the arrangement and design of a small plant suitable for adoption by *khangaris* and others who are already interested in sugar production, and that the efforts being made by the Agricultural Departments in the selection of varieties of sugarcane and improvements in cultivation will be rewarded with the success they deserve.

CATTLE FEEDING EXPERIMENTS IN DENMARK.

BY

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AT the last two meetings of the Board of Agriculture in India the question of the investigation of the relative feeding values of Indian cattle foods has been raised. At the last meeting, December, 1913, the conclusion was arrived at that "The Board considers that a scientific investigation could only be carried out by a special staff with special equipment such as could not at present be justified by the comparative importance of the results likely to be obtained."

This would seem to be a very wise conclusion, for, as will be illustrated in the following pages, the control of cattle-feeding experiments needs a large and efficient staff, since, in order that the experimental results may be reliable, a large number of animals have to be included in the feeding trials. There are so many other more important investigations to occupy the attention of the Agricultural Department that comparative trials of cattle fodders in India must necessarily be for the present shelved. One of the members of the Board of Agriculture even went so far as to remark, and with some truth, that the problem in certain parts of India was to keep the animals alive at all, apart altogether from finding which was the best food.

It must further be remembered that in Europe the farmers can afford to spend more on cattle food than can the Indian cultivator. This arises from the fact that in Europe cattle are kept wholly for milk or for beef production. In India the object is generally the production of animals for work.

Attempts are being made in many parts of India to improve the quality of the cattle. If these are successful the resulting animals will require more food. It would seem that these requirements would be met by an increase in the area and quality of pasture land and in the area of fodder crops grown.

The following account of various feeding experiments in Denmark sets forth the procedure in such work and some of the results which have been achieved.

Danish Feeding Experiments.

The writer has for some years been inclined to think more of the feeding experiments that have been carried out in Denmark than of any other feeding trials known to him. A visit to that country during the past year has tended to confirm his high opinion of these experiments. The work is not as widely known as it deserves to be, perhaps largely owing to the fact that the annual accounts of it are written in Danish and have never been fully translated into English. Certain portions of the reports have been translated into French in a very lucid manner by Mr. Mallèvre.¹ The writer is considerably indebted to these translations in the following account.

Cattle feeding experiments in Denmark were largely stimulated as a result of a difference in opinion in Germany and Denmark as to the feeding value of mangold wurzels. The Germans thought very little of mangolds as a cattle food, while the practical experience of the Danes went to show that they were very valuable for this purpose. As a result the Danes mistrusted the German teachings with reference to other food-stuffs. The Danish farmers approached Mr. Fjord and asked him to institute experiments to determine whether the concentrated foods could not be largely replaced by mangold wurzels.

Since that time the experiments have gone on continuously and many thousands of animals have been employed. Mr. Fjord died in 1891. The experiments now going on deal with milch

¹ Société de l'alimentation rationnelle du bétail. *Compte rendu du onzième congrès*, 1907.
Do. *Compte rendu du onzième congrès*, 1908.

cattle, pigs, horses, and chickens, and recently experiments have been started on the feeding of cattle for beef. In this article it is proposed to deal only with milch cattle, since in this way a good idea will be obtained of the great care which is expended in order to get reliable results. The pig-feeding experiments have been admirably summarized in Henry's "Feeds and Feeding," page 583.

One important feature of the Danish feeding trials is that they are not carried out at Government Stations with animals specially provided for the purpose. They are conducted co-operatively on a large number of farms under the direct control of the officials of the Royal Veterinary and Agricultural Institute of Copenhagen. These officials weigh and analyse all the food and products. The system has the advantage that it is less expensive to the State, it brings the Government Agricultural officials in closer touch with the farmers, and in many cases the work carried out is at the same time an experiment and a demonstration.

Mr. N. J. Fjord was the pioneer of feeding experiments in Denmark and his experiments were at the beginning purely private and carried out at his own expense. As their importance became more and more evident, the Danish Royal Agricultural Society made a grant of money for their continuation and expansion. Some years later the State also set apart an annual subsidy which has since been continued. The experiments are characterized by the special conditions under which they are carried out. In planning them the advice of the neighbouring farmers is taken, in order to take advantage of local experience, and to ensure that the problems are of local interest, and that the experiments are carried out under practical conditions. The farmers thus take a great interest in the work and therefore have more confidence in the results, since they have seen the work with their own eyes.

The centres of experiment are continually changed according as local conditions lend themselves to one or another series of experiments and hence the work gradually spreads over the whole country.

The work after a time reached such magnitude that it was at last necessary to have a central institution from which to direct it.

The State provided the necessary money, and as a result the Royal Veterinary and Agricultural Institute was built at Copenhagen and began its work in 1888. The experiments, however, still continued to be carried out on private farms just as before but all data are now collated at the Institute, where also all analytical work required is carried out. The Institute has been referred to in a previous number of this Journal¹ and no further description need be given here.

From time to time reports on the work done have been issued. Mr. N. J. Fjord issued 17 such reports on his private work, the last appearing in 1883. Since that time the Laboratory has issued about 80 such reports, all of which are serially numbered. Their subject-matter covers a very wide field such as Dairy Chemistry, Bacteriology, researches into animal diseases, and investigations into animal physiology, besides the feeding trials.

Description of a feeding trial.

It is hoped that the following account will give a good idea of the care expended on these experiments. A farm is selected where a herd say of 150—200 cows is kept. From the herd 40—50 cows are selected, all of which have just had their first calf. Three groups of 10 are then selected in which the animals are as evenly matched as possible. This gives a surplus of 10 to 20 animals of similar type, which can be rejected.

In order to ensure that all the groups are alike they are fed on the same ration for 2—3 months, the milk is weighed and the percentage of fat in it determined, the animals also being weighed every 10 days. If the groups show any difference they are rearranged and the work is begun over again and continued until all the groups come exactly alike. The ration fed during the above preliminary period contains the substances which are eventually to be compared. Having arranged the groups so that they are alike, they are kept on the same food for a further 10 days in order to see if they still keep alike. We will now take the case of an actual

¹ *The Agricultural Journal of India*, Vol. IX, Part 3, July, 1914.

experiment in which the relative feeding values of maize and wheat were established.

Experimental period.—One group will continue to receive the same ration as before. Another receives an extra ration of maize but no wheat. The third receives an extra ration of wheat but no maize. The experiment continues on these lines for 1—2 months during which time the milk is weighed and analysed, and the animals also are weighed.

Final period.—In this period the animals are all put on to the same diet again which is as nearly as possible the same as in the preliminary period. This period lasts 1—2 months and the yield and composition of the milk and the change in body weight are again determined. During this final period all three groups should give the same quantity of milk with the same quantity of fat and the same difference in body weight. If they do not, then the experiment is rejected. If they do, then one knows that the differences noted in the experimental period are due entirely to change of food.

The same experiment is carried out on 6—8 different farms for 2 years. In the end the comparative values of maize and wheat can be established.

The following is a short summary of an actual experiment. :—

| Daily ration. * | Preliminary period. | | | Experimental period. | | | Final period. | | |
|------------------------------|---------------------|-------|-------|----------------------|-------|-------|---------------|-------|-------|
| | A | B | C | A | B | C | A | B | C |
| Wheat kilogrammes .. | 1.09 | | | 2.12 | 1.06 | None | | 1.03 | |
| Maize | 0.89 | | | None | 1.06 | 2.12 | | 1.09 | |
| | A | B | C | A | B | C | A | B | C |
| Milk per day, kilogrammes .. | 13.80 | 13.80 | 13.80 | 11.75 | 11.85 | 11.55 | 10.65 | 10.65 | 10.65 |
| Daily increase in weight .. | 0 | -0.2 | 0.01 | 0.11 | 0.13 | 0.17 | -0.29 | -0.29 | -0.28 |

* Of course in addition to these the animals were receiving other foods which were always constant, viz., hay, straw, and mangold wurzels.

Hence this experiment was a good one.

The result is that 2.12 kilogms. of wheat produce the same effect as 2.12 kilogms. of maize as a food for milking cows,

Feeding trials on the above lines began in 1887, and up to date more than 4,000 cows have been utilized. Working on these lines it took 20 years to investigate fifteen feeding-stuffs. So far the general results of the feeding trials show that wheat, maize, and bran, all give much the same results in milk production, whilst oil-cake is slightly better. The following weights of the substances named have been shown to be of equivalent feeding value :—

Equivalents.

| 1 lb. | $\frac{3}{4}$ lb. | $\frac{2}{3}$ lb. | $\frac{5}{6}$ lbs. | $2\frac{1}{2}$ lbs. | 5 lbs. | 10 lbs. |
|---|--------------------|------------------------------|--------------------|---------------------|--------|---------------------|
| Wheat. Maize. Bran. Dry matter in mangold wurzels | Sunflower cake. | Cotton cake. Sesame cake. | Molasses. | Hay. | Straw. | Mangold wurzels. |

Effect of various foods on the composition of the milk.

The experiments have repeatedly shown that the changes of food have had practically no effect on the chemical composition either of the fat in the milk or of the milk itself. Changes in the composition of the milk are caused to a much greater extent by the individuality of the animal.

This is a convenient place to mention that the Danes find that pasteurisation is a sure way of removing the taints due to various feeding-stuffs from milk.

Control of the experiments.

In some of the more recent Danish feeding work, *viz.*, that described later in this paper, four men are kept specially to guard the cows. Two of these men are always on duty and must never leave the animals day or night. They are educated young men and take the necessary samples. They are also fully instructed in the details and objects of the experiment. During the course of the work these men receive only one half of their salaries. The other half is put by until the end of the experiment. The Laboratory reserves to itself the right to forfeit this half in case of any bad work or of bad faith on the part of the men.

Experiments on cost of production of milk.

Since 1906 experiments have been in progress in order to determine the cost of production of a given quantity of milk when using different food-stuffs. For the purpose of this experiment Red Danish, Jersey, and a cross between these two breeds have been tried. No difference has been established between these classes of cows. However, in order to show what an important line of work this is, it may be mentioned that similar work¹ on 59 farms in Surrey and Kent has shown that the cost of food to produce 1 gallon of milk varies from 3·83 pence to 10·54 pence, the average cost being 6·58 pence.

Researches on the amount of protein necessary for milch cows.

Until some 8 or 10 years ago the Danish feeding experiments had no other aim than that of being of purely practical benefit. Then came a time when certain of the results appeared to differ in some important matters from certain apparently well established physiological theories. In consequence the Laboratory was submitted to very violent attacks. In reply it instituted further researches, the results of which proved the correctness of its former work.

In this way there arose a high class series of researches having for their object the determination of the minimum amount of albuminoid nitrogenous matter necessary to be fed to milking cows. It is worth while to refer more fully to this research work because of the curious facts brought to light. The research has been fully described in the 60th report of the Laboratory published in Danish. In order to explain the origin of the research, it is necessary for us to study Danish agriculture shortly after the middle of last century, at the close of the war with Germany. It then became essential for the farmers, in order to improve their dairy industry, to produce large quantities of milk throughout the year, and not only in summer as heretofore. It was therefore necessary to reform the feeding

¹ First report on the cost of food in the production of milk in the Counties of Kent and Surrey, 1908-9-10. James Mackintosh, South Eastern Agricultural College, Wye.

of their cattle. Hence, to the hay and straw already fed, they added concentrated foods, such as cereal grains and oil-cake. Mangold wurzels, at that time little cultivated, formed a very small part of the rations of cattle. As a result the milk yield was increased by the feeding of large quantities of concentrated food, which however was a very costly proceeding. As the growth of mangold wurzels spread, it was seen that great economy could be effected by substituting them as far as possible for concentrated foods in rations. The question to be decided was to what extent they could take the place of concentrated food in the ration without detriment to the milk supply or the health of the animals. Apart from the large amount of work which would be thrown on the digestive tracts by the assimilation of such large rations of mangold wurzels, a total substitution seemed unthinkable. The mixture of straw, hay, and mangolds is very poor in nitrogenous matters, and the addition of certain amount of concentrated food rich in protein seemed indispensable. From reasons of economy, however, a large number of farmers had pushed the substitution very far, so far in fact that the question arose whether they had not surpassed the safe limit. The opinion of scientific men was divided. The Agricultural Laboratory thereupon submitted the point to the test of experiment. These particular trials were carried out in 1900 to 1901 on 48 lots of ten milch cows each and the results were published in the 55th report of the Laboratory. They led definitely to the conclusion that during winter the substitution of mangolds for cereal grains or oil-cake could be made within large limits without detriment to the production of milk, the maintenance of the live weight or the health of the cows. Animals weighing 475—500 kilogrammes, kept in good condition, gained daily 100—150 gms. and yielded during the winter months 11—13 litres of milk daily, quite indifferently whether they were on a ration of

| | |
|------------------|-------------------|
| 4·5 kilogms. | .. Straw. |
| 4·5 " | .. Cereal grains. |
| & 10—15 " | .. Mangolds. |
| or of 4·5 " | .. Straw. |
| 4 " | .. Hay. |
| 2 " | .. Cereal grains. |
| and 40—45 " | .. Mangolds. |

Out of these experiments arose the controversy referred to above. The critics would not allow that a ration such as the last would permit of the production of 11—13 litres of milk daily without loss of nitrogenous substance from the animals' tissues, and hence, without endangering the health of the animals.

In order to follow the discussion further it is necessary to call attention to the minimum amount of digestible nitrogenous matter¹ which various investigators had held to be necessary in an animal's food when at rest and producing no milk, in order that it should maintain its body weight. According to Wolff and Lehmann's tables for a cow of 500 kilogrammes live weight at least 350 grams of digestible nitrogenous matter must be fed daily. This figure agrees with the tables of Kellner. More recent work by Henneberg and Stohmann, G. Kuhn, and Kellner showed that the minimum figure might be as low as 300 or even 250 gms.² Armsby's work showed that 3 cattle at rest weighing respectively 420, 450, and 400 kilogrammes which were fed for 71 days on hay were kept in nitrogenous equilibrium by a ration containing 225, 222·2, and 243·8 gms. of nitrogenous matter per day per 500 kilogramme live weight—a mean figure of 230 gms.

As a matter of fact, the figure for the daily amount of necessary digestible nitrogenous matter which was generally accepted by the authorities at that time, for maintaining the body weight of an animal weighing 500 kilogrammes, doing no work, and producing no milk, was 350 gms. If an animal was producing 5 kilogrammes of milk per day, then it was generally agreed that another 350 gms.³ of digestible nitrogenous matter, or 700 gms. in all per 500 kilogms. body weight, would have to be fed. From this figure it can be calculated that a cow giving 20 kilogms. of milk daily would have to receive a ration of at least 6 kilogms. of cotton cake in addition to mangolds, hay, and straw. Such a ration is practically impossible.

¹ (Nitrogen $\times 6\cdot25$.)

² "Maintenance Rations of Cattle." Bull No. 42. Pennsylvania State College Agri. Exp. Station. 1898.

³ Vide Kellner, Armsby, and Hanson. Haecker of Minnesota, however, gives a figure much lower than this.

The criticisms against the Copenhagen experiments were based on the above figures. The critics said if you subtract from the total digestible nitrogenous matter which you feed to each animal per day the 300 to 350 gms. generally recognised as necessary for maintaining the nitrogenous equilibrium of an animal at rest and producing no milk, then the remainder will not be sufficient to make up for the nitrogen secreted in the milk, the yield of which, it will be remembered, was 11—13 litres a day in these experiments. Matters are still worse, they said, if it be remembered that in rations rich in mangolds as much as 20 per cent. of the digestible nitrogenous matter is in a non-proteid condition and of less use for nutrition.

Hence one of two things must follow. Either the animals drew on the nitrogen of their own tissues in order to supply the milk, or else there must have been some very large error in the experiments.

Thus confronted by critics the Laboratory had to maintain its reputation. They were certain there was no error in their experiments, and it seemed as though the animals must have lost nitrogen from their body tissues. It was surprising, however, that their body weight had not decreased. It had in fact shown a slight increase. The question then arose whether the animals were laying on non-nitrogenous matter in the form of fat, and by this source of gain masking the loss due to waste of nitrogenous tissues.

The Laboratory decided there was a certain though difficult way of clearing up the problem. This was to feed cows on rations rich in mangolds and hence poor in nitrogenous constituents, that is rations similar to those employed in their feeding trials of 1900-01, and then to keep a careful balance sheet of the nitrogen being fed to the animals and of that given out by them, in their faeces, urine, and milk. Such experiments were carried out, and their results are set out in the 60th report of the station. The experiments were very comprehensive and, by a scale of rations poorer and poorer in protein, showed definitely what was the indispensable minimum that milch cows ought to receive daily in order that they should maintain their body weight and not lose nitrogen from their own tissues.

In all nine cows were included in this experiment and they were kept continuously under experiment from the beginning of November, 1905, till July, 1906, and 200,000 observations were taken. During the course of the experiment each cow received a ration in which the proportion of concentrated food-stuffs (fed as cotton cake) to that of mangolds varied from time to time. The total weight and nitrogen content of all food given was determined, as was also the total weight and nitrogen content of the milk, urine, and faeces. In some cases the proportion of mangolds to cotton cake was very high indeed, and cases were found where the animals had to draw on their body tissue in order to supply the nitrogen excreted in their milk, urine, and faeces.

In order to illustrate the results we will consider the typical case of a cow (numbered 68 in the above report). There were 16 periods throughout the duration of the experiment, during each of which the animal was receiving a varying proportion of mangolds, cotton cake, hay, and straw. During each period the daily amounts of nitrogen in the food, faeces, urine, and milk were determined. The amount of nitrogen in the food varied from 151 gms. daily to as much as 329 gms. daily. For our purpose we will consider the 8th to the 13th periods which lasted from the 6th February to the 25th April, 1906, or 79 days in all. During this time the cow consumed a ration rich in mangolds and poor in cotton cake. The actual ration was throughout somewhat as follows :—

| | |
|------|-------------------------------|
| 5 | kilogrammes of straw. |
| 2·5 | " " meadow hay. |
| 1·25 | " " decorticated cotton cake. |
| 4·5 | " " mangolds. |

The animal's weight was 453 kilogrammes at the beginning and 457 kilogrammes afterwards. Hence its weight kept fairly constant. The average production of milk was rather over 13 litres per day. Its average daily intake of nitrogen in its food was 191 gms. It excreted in its faeces 90 gms., in its urine 34, while the milk contained 59 gms., making a total of 183 gms. of nitrogen. Hence the animal's body was gaining daily $191 - 183 = 8$ gms.

of nitrogen. There is therefore here a cow, which, during $2\frac{1}{2}$ months, has suffered no loss in weight of its own nitrogenous tissues and has given an average daily yield of 13 litres of milk, and that on a ration rather poorer, from the nitrogenous point of view, than that fed to the cows in the experiments of 1900-1. As has been seen these rations were denounced by the critics as being too poor in nitrogen for animals yielding 11-13 litres of milk. It will be convenient to call the reader's attention here to the fact that of the nitrogenous matter fed in the food only about 50 per cent. is digestible. Hence the above animal was receiving 95.5 gms. digestible nitrogen daily equal to 95.5×6.25 , that is, 596 gms. digestible nitrogenous matter. According to the critics it should have received (350 gms. + $\frac{350 \times 13.28}{5}$) ¹ $\times \frac{455}{500}$ equal to 1,163 gms.

The experiments thus upheld the previous feeding experiments of 1901-2, and also showed that the accepted figures for the amounts of nitrogenous matter required by milking cows were much too high. It may be of interest here to note that the experiments further showed a close connection between the amount of nitrogenous matter in the food and the amount of nitrogen excreted in the urea. As the food became less nitrogenous so did the nitrogen content of the urine decrease.

Before leaving the subject of the minimum desirable nitrogen content of cattle foods, reference may be made to work at the Minnesota Agricultural Station by Haecker and described by Benedict.²

Two lots of cows were taken. Lot A received a ration containing the normal quantity of protein, and lot B one much poorer in nitrogenous matter. The experiment spread over three years. For the first two years there was no observable difference between the two lots. During the latter half of the third winter, lot B began to get thin and their skin became hard to the touch, a sign of bad nutrition. The amount of nitrogenous matter in their food was increased and they at once recovered their normal state. Thus up to a point Haecker's experiments confirm the Danish ones, but

¹ Its daily yield of milk was 13 litres, roughly 13.28 kilograms. The animal weighed 45 kilograms.; hence fraction $\frac{455}{500}$.

² Benedict. *American Journal of Physiology*, 1906.

they go beyond them by showing that over long periods a low protein diet is not desirable. Practically, Hæcker's results, however, have no significance to the Danes, for it is only during the winter months that they feed low protein diets of mangold wurzels. During the summer months their animals get plenty of pasture and green fodder, which contain sufficient nitrogenous matter.

Hence, this series of Danish experiments establishes the fact that the Danes can substitute during the winter less expensive foods such as mangolds for expensive foods such as cotton cake without decreasing the yield of milk or endangering the health of the cattle.

It may be of interest to remark that Dr. Hindhede who was responsible for much of the above work has recently turned his attention to human nutrition. His results¹ seem to show that here again the nitrogenous content of human food is much too high.

¹ Hindhede. *Protein and Nutrition—an investigation.* Ewart, Seymour & Co., London.

THE IMPROVEMENT OF CANE CULTIVATION IN THE SOUTH CANARA DISTRICT.

BY

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IN 1907, when little was known of the agricultural conditions of the West Coast, a trial crop of sugarcane was grown on the newly opened Agricultural Station at Taliparamba in North Malabar. This was an entirely new crop to this part of the West Coast, thus the methods of cultivation adopted were suggested by the experience gained in the drier districts of the East Coast. Considerable stress was laid on two points, *viz.*, adequate manuring and drainage. On the East Coast it is the practice to manure very heavily either with cattle manure and green leaves or, in places where the supply of these is insufficient, with oil-cakes either castor or groundnut. Cattle manure is not available in any quantity in Malabar and the price of oil-cakes is prohibitive. Fish manure (beach-dried sardines) is, however, plentiful in most seasons at reasonable rates and this was used as a manure for this trial crop. Two varieties were tried, *viz.*, Red and Striped Mauritius. These were planted in trenches 4 feet apart in March and were earthed up before the monsoon broke in June. As the South-West Monsoon is very heavy (the rainfall for June, July, and August averages about 100 inches) and the air is laden with moisture, particular attention was paid to drainage. Deep trenches were dug between the rows of cane and high ridges were formed along the rows. These trenches were all connected with a deeper trench which carried off all surface water. The growth of this crop exceeded all expectations and was as good as that of the heaviest crops on the East Coast.

After the monsoon of the same year, when touring for the first time in the South Canara District, the difference between the pale and stunted crops there and those raised on the Agricultural Station in the adjoining district was very marked indeed. A few sets were accordingly distributed at the next planting season through the District Agricultural Association of South Canara and these were planted on one of the backwater islands in the river near Mangalore. These crops were inspected later in the season and though the Red Mauritius proved itself to be a much more vigorous variety than the local cane and gave what in the locality was considered an excellent crop, it could not be compared with the luxuriance of the crops on the Agricultural Station. This was attributed (and rightly as it afterwards turned out) to the lack of adequate drainage and manuring. An officer of the Department was then sent to tour in the cane tracts of the district to get into touch with actual cane cultivators. A few of these in the Mangalore, Udupi, and Coondapur Taluks were induced to try these canes, and further these cultivators were induced to adopt the methods of cultivation and manuring which had proved so successful on the Taliparamba Agricultural Station. In a few cases one of the permanent labourers from the Agricultural Station was sent to assist in the planting. The results of these trials showed that just as good crops of Red Mauritius canes could be grown in South Canara as on the Agricultural Station.

Thus, by introducing a new cane and insisting on certain methods of cultivation, it was possible to introduce better methods of cane cultivation which would have been practically impossible if attempted in the first instance with the local cane. Subsequently the cultivators, finding that wider planting, better manuring, and adequate drainage gave such satisfactory results with the new cane, successfully adopted these methods of cultivation for their local canes. The Red Mauritius, however, at once found favour on account of its great vigour, and it is generally stated by those who have cultivated it that it yields half as much again as the best local variety. It may be asked, however, why the Red Mauritius, if it gives such good results, has not entirely supplanted the local cane.

There are two reasons, firstly, much of the thick cane grown in the district is sold for chewing; and for this purpose the local thick soft-rinded canes are much preferred to a hard-rinded cane like the Red Mauritius. The cultivating Roman Catholic Christian, among whom cane cultivation is practically confined, is usually only a petty cultivator, and depends on his industry for his livelihood, and thus has to live a hand-to-mouth existence. By selling the local cane in small lots for chewing, he can manage to exist until the bulk of the crop is ripe for making jaggery. Secondly, the local thick canes, accustomed as they have been for centuries to very close planting, do not tiller freely like the Red Mauritius, thus they ripen more evenly, the canes being practically all of the same age. At the end of the monsoon jaggery is always scarce, especially in those parts of the district which are only accessible by sea; for during the monsoon all the ports are closed. Thus considerably higher prices are paid for jaggery immediately after the monsoon and the local soft-rinded thick canes are then in considerable demand for milling.

It seems probable therefore that though the bulk of the crop will in the future be Red Mauritius there will always be a considerable area of the better local canes under cultivation. The fact, however, that the Red Mauritius is a hard-rinded thick cane has meant, and will mean in the future, a considerable expansion in the area under cane. Up till the introduction of this variety, the cultivation of thick canes was practically confined to the islands in the river backwaters, for if grown on the main land very considerable damage was always done to the crops by jackals. The Red Mauritius cane being proof against the attack of these has meant that thick canes can replace and have in many places replaced the *Karri kabbu*—the local hard-rinded red cane. This has greatly extended the possibilities of profitable cane cultivation.

When Red Mauritius canes were first successfully grown a new difficulty arose in milling them. Up till that time, the iron cane mill was unknown in the district and it was found that the local wooden mill could not properly crush these thick hard canes. If this cane was to stay it was essential that a better mill should be

introduced. Although iron mills have entirely replaced the old wooden mill on the East Coast, the introduction was a real difficulty in South Canara owing to the poverty of the cane growers. Moreover there were serious misgivings in the minds of the people that the iron mill would need a much heavier draught than their cattle could manage. After considerable inducement one or two men who were professional jaggery makers were induced to purchase iron mills, when the better extraction of juice and the more rapid work soon became evident, and all doubts as to the capacity of their cattle to drive the mill were removed.

The very fact, however, that these iron mills did more efficient work led up to another difficulty. It was found that the primitive methods in vogue of jaggery making could not cope with the rapid extraction of juice, and, if these mills were to come into general use, it was necessary to improve the methods of jaggery making. Further, improvements in jaggery making were essential if the area under cane was to be maintained, let alone increased. The primitive hearths had no through draught, while the pans for boiling were very small. Thus there was not only a great waste of fuel through incomplete combustion, but there was a great waste of heat. Even as far back as 1801 Buchanan wrote "the want of firewood is the greatest obstacle to this cultivation."

Accordingly in 1911 an officer of the Department who had a practical knowledge of jaggery making was sent to this district to erect proper furnaces and to introduce larger pans for boiling juice. These were erected in centres where the iron mill had been introduced, and, meaning as they did a great saving in fuel and thus in the cost of preparing jaggery, they have generally come into favour while the old wooden mill has now practically disappeared from the district.

These last two years have seen a steady advance in the sugar-cane industry of South Canara. There has been a general improvement in the methods of cultivation. The canes are planted further apart, attention is given to manuring, drainage, and weeding, and much greater economy is effected in the manufacture of jaggery. The area in the district grown with Mauritius canes is this year

reported to be 194 acres, or 10 per cent. of the total normal area. This does not seem at first sight a very large item, but when it is considered that an individual holding of cane probably averages 10 to 15 cents this means that the Department has got into touch with, and has gained the confidence of, a very large number of hardworking small ryots, while the fame of these new varieties of cane has spread not only throughout the district but into the adjoining territories of North Canara and Mysore.

Reading Buchanan's¹ account of the cane cultivation in this district written in 1801 and comparing it with the cultivation as practised in 1908 it is evident that no innovation in the methods of cultivation had been introduced within that period. The only innovation apparently had been the introduction of a new variety called locally *Dassa Kabbu*—the *Nammalu* of the East Coast—into the Mangalore Taluk. Yet within a period of 5 years the Department has been able, by the introduction of a new variety of cane, to effect many improvements not only in the cultivation but also in the manufacture of jaggery.

Granted that the cane crop is of minor importance in this district, the work is of much greater significance than is at first apparent, as it has paved the way for other and more important district work; and the ryots now realize that the officers of the Department are not merely Government officials, but have a practical knowledge of farming, and can by their advice and guidance render them considerable assistance in improving their local methods of agriculture.

¹ Buchanan's *Mysore, Canara, and Malabar*.

NOTES ON THE CULTIVATION OF BERSEEM.

BY

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UNDER the name of Berseem are included the various kinds of clover grown in Egypt, which are all varieties of *Trifolium Alexandrium*.

The growth of this crop is very advantageous from an agricultural point of view, for the following reasons :—

(i) Berseem tends to prevent the diminution of humus in the soil.

Decomposition proceeds very rapidly in India, so that, with the aid of irrigation, there is a tendency to serious loss of humus. The roots of berseem and a little stem are left in the ground in all cases.

(ii) It is very successful in opening up the soil.

(iii) It possesses a high manurial value as belonging to the *Leguminosæ* family. It has the power of fixing the nitrogen of the air, and converting it into plant food.

The roots of berseem have been found to contain about 55 lbs. of nitrogen per acre. If, however, the crop is allowed to seed, the roots lose most of this nitrogen, which goes to assist in the formation of the seed.

(iv) It is excellent as a food both for horses and dairy stock.

In Egypt during its period of growth it forms the only food for stock.

Varieties.

There are four chief varieties of Berseem, viz., Fahl, Saidi, Miscawi, and Khadrawi; of these only the two latter are

worthy of consideration for Military Farms, *viz.*, Miscawi and Khadrawi.

The berseem grown in Lahore is almost certainly Miscawi, which is by far the most important variety. It is tall, luxuriant in growth, and yields an astonishing amount of green food. It is very largely grown under perennial irrigation, requires plenty of water, and will give four or five cuttings and a seed crop.

Khadrawi is not largely grown in Egypt. This variety resembles the Miscawi, also requires a lot of water, but gives more cuttings.

Cultivation.

The land should be prepared more or less as for an ordinary *rabi* crop, but one or two ploughings with a native plough are as a rule sufficient.

Manures are not necessary as the growth is quite satisfactory without them. It will grow well on most cultivated soils. The plant will not grow on salt lands, but is extensively used on lands in the process of reclamation after *Panicum Crus-Galli*, or rice. When *Panicum-Crus Galli* or rice has been successfully grown on land, it is followed by a crop of berseem. If this grows well, the land is considered reclaimed, as all other crops follow. Unreclaimed land is generally poor in organic matter and nitrogen, and for this reason berseem growing is extensively advocated.

The seed should be sown about the middle of September to the extent of 40 lbs. per acre. The land is heavily watered (about 2" deep), and the seed is broadcasted on the water. It sinks to the bottom and, the water having disappeared, the seed quickly germinates. The day before sowing, the seed should be soaked overnight, and sown about midday.

When the seed is sown early and gets the benefit of the warm weather the plants grow rapidly. There is danger in early sowing as the young plant is subject to the attacks of surface caterpillars and cotton worm.

Late sowing, however, may retard the crop greatly, since cold weather in the early stages will almost stop the growth. About

two to three waterings will be required before taking the first cutting (45 to 80 days after sowing, dependent on the weather). The crop should be cut when about 15 to 18 inches high.

The crop should not be in actual need of water when cut, as it is important that the soil should be just moist enough to stimulate the plant to grow again when cut. This is best done by watering about ten days before cutting. A few days after cutting, the crop is watered again, and usually gives a second cutting in from 35 to 40 days.

With early sown berseem as many as five or six cuttings can be obtained.

The early cuttings of berseem contain a very large percentage of water (about 86 per cent), and for that reason are not suitable for hay-making. The later cuttings can be made into hay or "Driss." These cuttings contain less water and readily dry into hay. The process is very simple, the crop is cut and left to dry on the ground, and then carried. It is usual, if seed is required, to allow, in the case of early grown berseem, the fifth crop to flower and seed, and, in the case of late grown berseem, the fourth crop.

Seed.

The average sample of seed usually contains some 7 per cent. of impurities, mainly chicory and wild mustard. These are both edible, but opinions on their desirability are divided. The Agricultural Officer, North-West Frontier Province, states the presence of chicory is desirable as it prevents "hoven"; the Egyptian authorities, however, state that it tends to cause scouring, and to kill out the berseem. It was noted that after each cutting the amount of chicory decreased.

Report on growth in India.

The seed was first sown in the winter of 1912-13 at Ferozepore and Lahore.

At Ferozepore it was sown on manured land ($1\frac{1}{2}$ acres), and was most successful, giving an outturn of 34,977 lbs. or 437 maunds per acre.

At Lahore, owing to a change of staff, nothing was known of the seed having been ordered until about a week before its arrival. The only land available was some $2\frac{1}{4}$ acres of inferior land, on which a crop of rice had been grown in the previous *kharif*. The plot was ploughed twice, and the seed sown. The outturn was fair, and in conjunction with results obtained at Ferozepore it was decided to continue its cultivation.

Ten maunds of seed were obtained, and one maund was transferred from Lahore to Multan and Lucknow Grass Farms.

The seed was sown between the 1st and 10th of October, and the first cutting was ready about the 20th November.

The seed was obtained originally from the Deputy Director of Agriculture, Sind, who cannot now supply it, but seed can be obtained from the Sind Reclamation Company, Mirpurkhas, for Rs. 16 per maund.

As the seed is not harvested in Egypt until June or July it is difficult to obtain it in India before October, but this year it has already been obtained, and will be sown earlier, when even better results should be obtained.

Outturn.

Lahore.—The total outturn from 15 acres was 537,143 lbs. exclusive of $\frac{1}{2}$ acre left for seed which yielded 150 lbs. of seed, giving an outturn (green) per acre of 35,809 lbs. The fodder was issued at 35 lbs. equal to 20 lbs. of hay, so the outturn on a hay basis per acre was 20,462 lbs. or 255 maunds.

The $2\frac{1}{4}$ acres previously sown in the year before were re-sown and gave six cuttings as under:—

| | | | | | |
|-------------|-----|-----|-----|-----|-------------|
| 1st Cutting | ... | ... | ... | ... | 11,200 lbs. |
| 2nd Cutting | ... | ... | ... | ... | 18,073 .. |
| 3rd Cutting | ... | ... | ... | ... | 28,763 .. |
| 4th Cutting | — | ... | ... | — | 31,364 .. |
| 5th Cutting | — | ... | — | ... | 24,552 .. |
| 6th Cutting | ... | — | ... | ... | 6,458 .. |

Total ... 120,410 .., or 53,515 lbs.
per acre

equivalent to 30,580 lbs. of hay or 382 maunds.

This conclusively proves the value of soil inoculation with regard to this crop. The principle now to be followed is, where land has given but a poor crop of berseem, to re-sow with berseem the next year when, if the crop is successful, the land may be considered as good for all crops. The $2\frac{1}{4}$ acres in question will now be put down to grass. A small amount, *viz.*, 4,200 lbs. of green berseem, was made into hay, but only gave an outturn of 600 lbs. The Divisional Veterinary Officer bought this, and stated the hay was an excellent fodder, but the loss is heavy and as in the case of lucerne hay it tends to become very brittle.

Multan.—Two and a half bighas (5,000 sq. yds. or 1.033 acres) were sown on the 1st of November. The land had been heavily manured and the resultant outturn was 97,345 lbs. in three cuttings. The outturn per acre was therefore 94,235 lbs. green = 1,178 maunds, which is equivalent to 674 maunds per acre of hay.

The crops were retarded by frosts during the month of December.

Remarks.

The value of berseem in reclaiming land has been fully proved.

The eagerness with which all classes of animals devour this fodder is phenomenal.

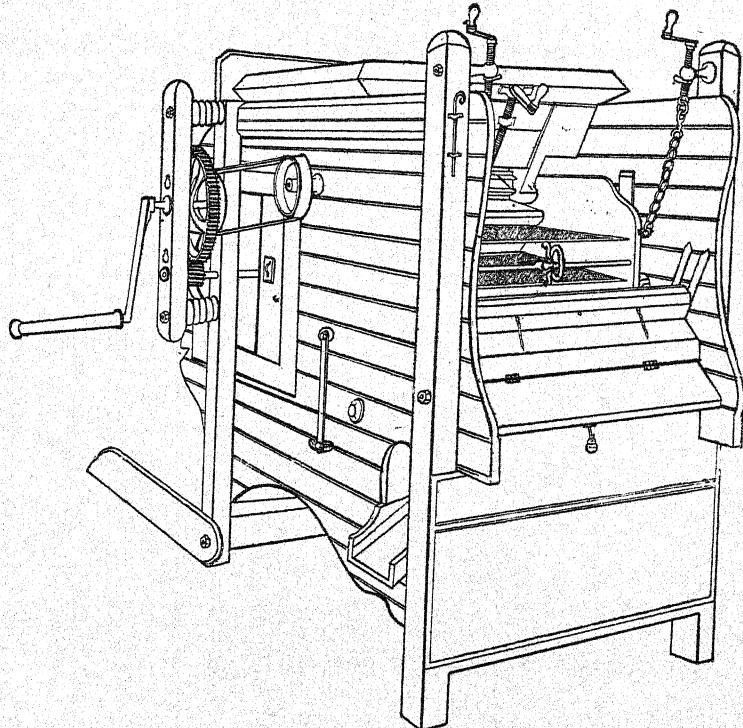
The crop becomes available for issue before lucerne and the ordinary *rabi* crops are ready.

The Text-book of Egyptian Agriculture has been the main source of all the information given above.

[Importers of seed should endeavour to obtain seed free from dodder which is a serious pest of this crop in Egypt and has been imported thence into all countries which have introduced berseem (see *Agricultural Journal of India*, Vol. VIII, Part III, p. 306.)—EDITOR.]

NOTES.

A WINNOWING MACHINE.—A NEW Winnowing Machine has been recently obtained for the Central Farm, Coimbatore, and has been given a short trial during which it proved quite satisfactory. It is too expensive a machine for recommendation to ordinary farmers, but for work on a Seed Farm or Experimental Station it may be recommended. The selection of sieves was made, on



consideration of a series of actual samples by the makers themselves, and should tackle all grains.

The machine is made by Thomas Corbett of the Perseverance Iron Works, Shrewsbury. It is known as the A. 3 winnower with

desired effect. If the clods dry, the disks cannot break these properly. The "Norwegian Harrow" does little better.

The "Disk Harrow" costs from sixty to one hundred rupees. The "Norwegian Harrow" costs about two hundred rupees. Both these require four bullocks to draw in the soils of the Deccan.

In the present implement an attempt has been made to combine a harrow and a planker or a float to break the clods effectively.

The front part or harrow proper (see Fig. 1, page 88) tears the clods and the float pulverises them. The former is made of wood with iron teeth and can be repaired locally. The cost of the wood may be up to fifteen rupees, but generally the cultivators do not have to purchase wood for implements. They use *babul* wood from their farms. The teeth may cost about six rupees. This instrument, as devised, is $5\frac{1}{2}$ feet long by fifteen inches wide, by five inches deep, and it carries thirteen teeth in two rows set alternately. The distance between the teeth in the row is nine inches, and since they are set alternately they cut tracks four and a half inches apart. The teeth are strong; they are curved and flattened at the point. They break and tear the clods with fair success.

The harrow is provided with two wheels which can be lowered or raised by means of a lever.

The harrow has done excellent work even without the lifting arrangement shown in the illustration, but it was found too heavy to lift for cleaning or for relieving it from weeds, etc., when worked in moist soil as a "cultivator." If the lever, with which the harrow is provided, is pulled back, the harrow is lifted and can then easily be relieved of the weeds.

The wheels can be used to adjust the depth and to bear the weight of the harrow. They are, moreover, very useful for removing the implement from one field to another.

The float or planker (Fig. 2, page 90) goes behind the harrow and crushes the lumps effectively which have been already partly broken. The planks are so arranged that they catch and strike the clods as it is drawn over the soil. The planks lap over one another, presenting edges which break the clods and do not merely push them into the soil as the *Maind* does.

Three planks $5\frac{1}{2}' \times 7'' \times 2\frac{1}{2}''$ are fixed in the two runners in a slanting direction, each just overlapping the edge of the plank in front as shown in the picture. The lower edges of the planks are protected by means of iron bands.

When the complete implement (Plate III) is worked the harrow carries the float behind it. The float balances the forward pull on the harrow and enables it to hold in the ground without

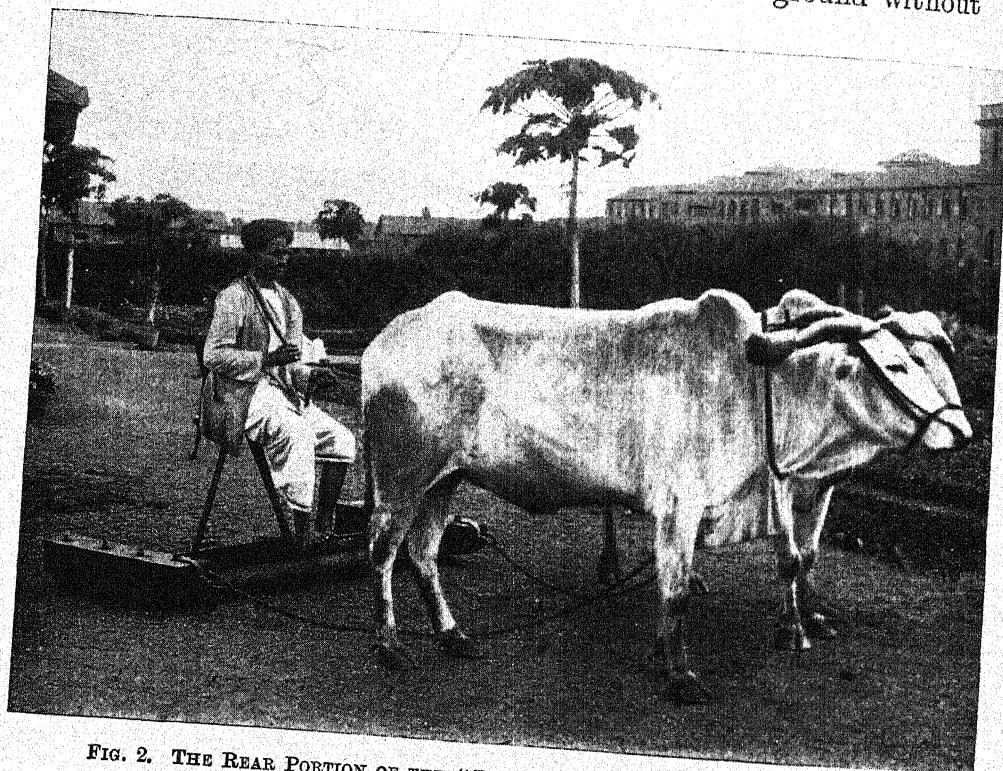


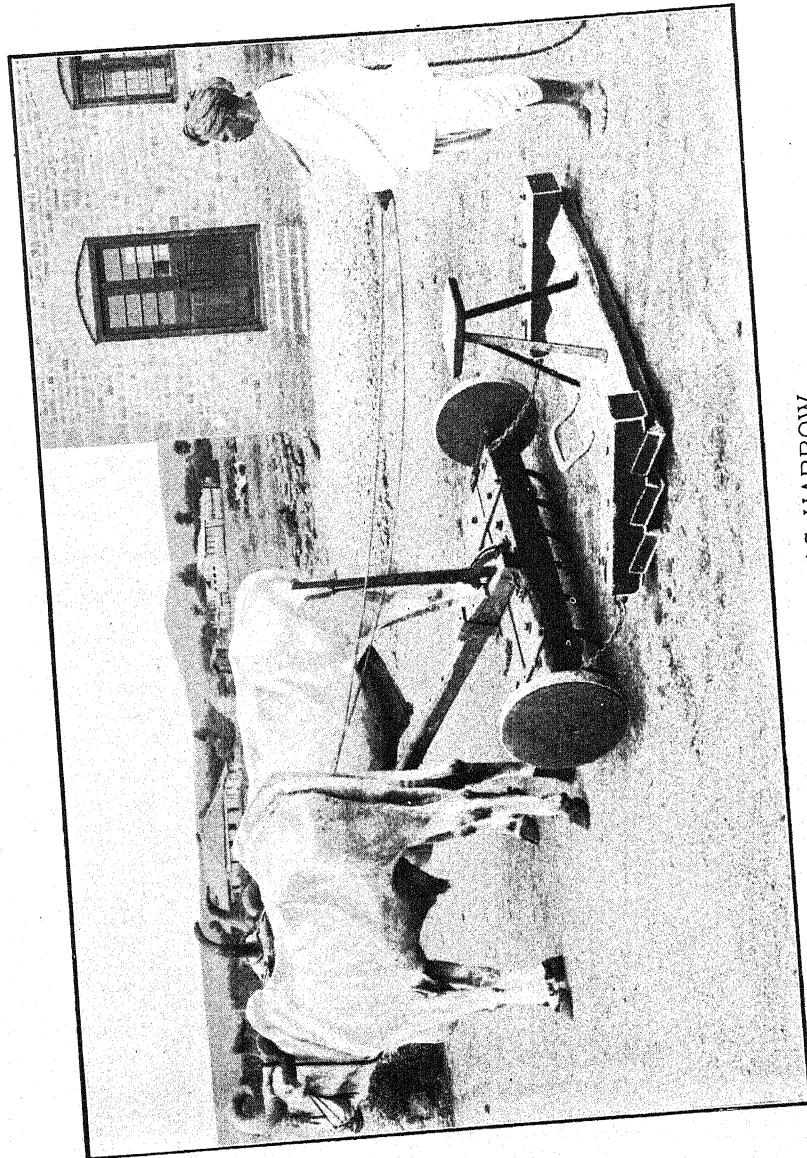
FIG. 2. THE REAR PORTION OF THE "DRAG HARROW."—THE FLOAT OR PLANKER.

jumping about. Four bullocks are required to draw the implement.

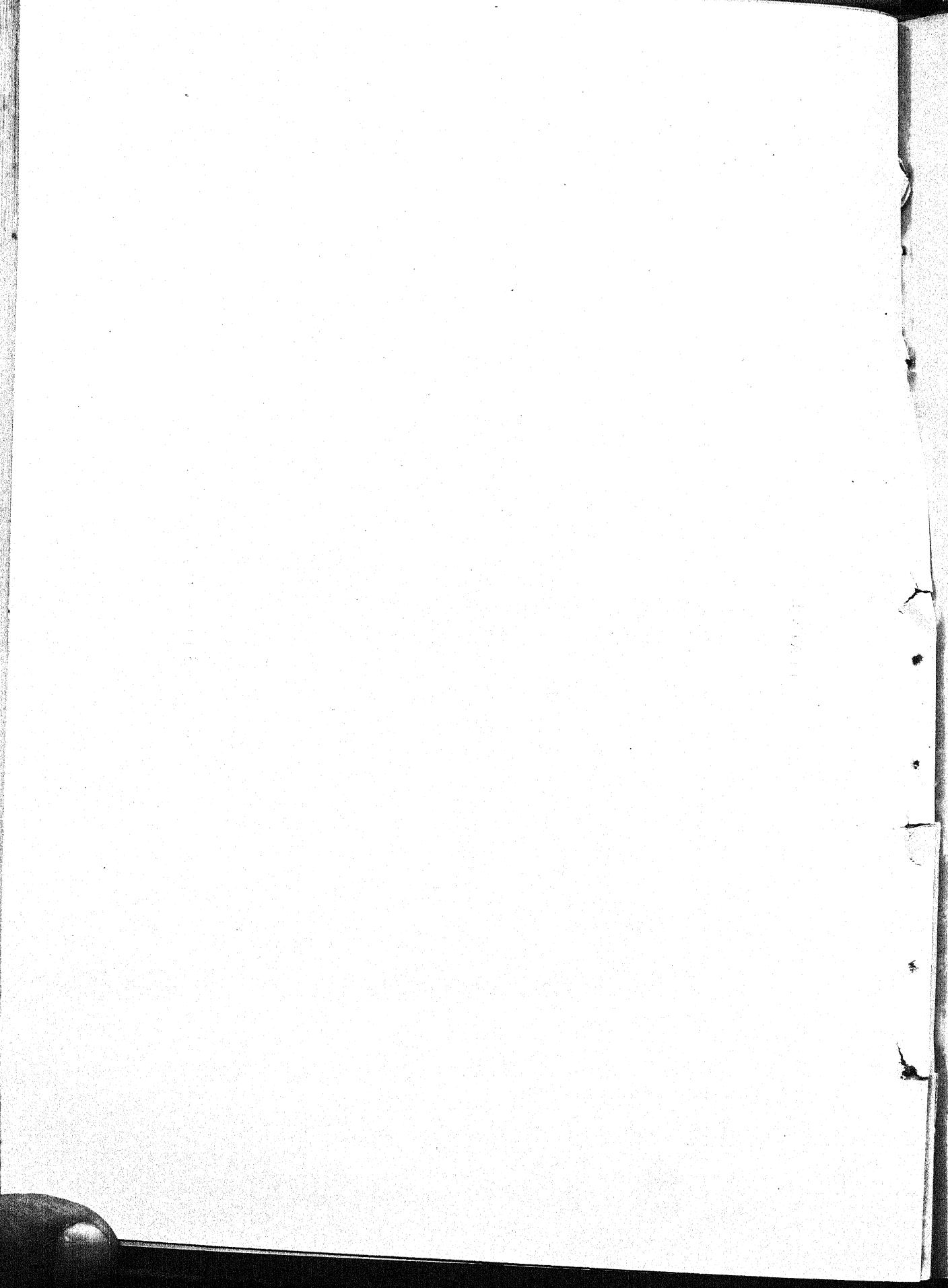
The front portion (harrow, Fig. 1) can be used to stir the soil deeply as a preparation for *kharif* sowing. Four bullocks will be required for this in damp heavy black soils.

The float (Fig. 2) when used alone makes an admirable leveller and is a decided improvement on the log harrow. When worked alone chains may be used. Only two bullocks are required since it is used when the soil is dry.—(P. C. PATIL.)

PLATE III.



THE DRAG HARROW.
(Complete in working order.)



IMPROVED FRUIT BOXES.—The packing and transportation of fruit under Indian conditions was dealt with in some detail in a recent issue of this Journal (Vol. VIII, Part III, 1913). In the paper in question, a detailed account was given of the various packages taken up by the trade at Quetta together with a statement of the general lines of progress likely to yield useful results in the immediate future.

During the present year, further progress has been made at the Quetta Fruit Experiment Station in designing suitable fruit packages for the five-seer parcels rate. In the original Quetta peach crates, chip compartments were used for each peach and laths were employed for the top and bottom of the box. The separate laths were found to be unsuitable in practice on Indian railways on account of the comparative ease with which thefts in transit could be carried out without risk of immediate detection on delivery of the crates. Further, the labour of making the separate chip compartments was considerable.

Two changes have been made in the Quetta peach crates by which the above disadvantages have been entirely removed. In place of the separate chip compartments, a collapsible cardboard fitting has been used instead. This folds flat and is imported ready for use. Two box boards, which leave a ventilation space of about one-third of an inch down the middle of the box, are used instead of the narrow laths. These cannot be removed in transit unless the lead seals are broken. The arrangement will be clear from Fig. 1

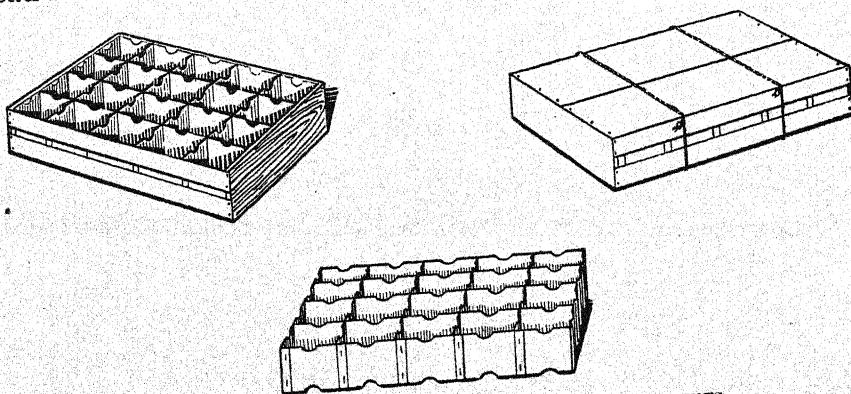


FIG. 1. PEACH CRATES WITH CARDBOARD COMPARTMENTS.

which shows on the left, a crate with the cardboard fitting inside; on the right, a crate ready for despatch with a separate cardboard fitting below.

During the past year the whole stock of these improved crates, nearly five hundred in number, were at once sold to the trade and proved entirely satisfactory under Indian conditions.

At the same time, a fruit box on the same principles as the above, but made entirely of cardboard, was put on the market at Quetta. The whole of the outside of the box consists of a single piece of cardboard and the boxes can be set up very rapidly. The separate compartments are of cardboard on the same principles as those shown in Fig. 1. With these cardboard boxes, thefts in transit are quite impossible. One hundred and forty-four of these boxes were imported, and of these only a few were offered for retail sale as the majority were at once bought up by the fruit merchants. Judged by the demand in the Quetta market in 1914, cardboard fruit boxes are likely to become exceedingly popular in India and steps have been taken to import a larger number for use at Quetta next year.

The crates introduced at Quetta for twenty medium and fifteen large peaches are being adapted for other fruits by the simple expedient of changing the inside cardboard fittings. The fifteen peach crate with three and a half inch cube compartments will serve not only for large peaches but also for dessert apples, apricots, cherries, and plums. A four-compartment cardboard fitting renders these crates suitable for grapes. The twenty-peach crates, with three inch cube compartments, are suitable for ordinary peaches, nectarines, and medium-sized apples. These two crates, one of which will have two kinds of cardboard fittings, will serve for five-seer parcels of most of the fruits grown at Quetta which are suitable for long distance transport. Work is now in progress to ascertain the cheapest source of the materials required for these packages and to compare Indian with imported wood.—(A. HOWARD.)

IN the July (1914) number of *The Tropical Agriculturist* there is a very instructive article entitled "Improvement of Rice by Selection in Java," by Dr. J. Van Breda De Hann, which should prove interesting reading to those engaged in similar work in India. The article summarizes in some detail the important work which has been carried on at Buitenzorg during the past ten years by Moquette and Van der Stok, and the results achieved. The first work undertaken was to obtain as complete a knowledge as possible of the different species and varieties of rice cultivated in the Island. Samples were collected from all parts and roughly classified according to the external characters of the ears, grain, awns, etc., after dividing the samples into the two broad classes of glutinous and non-glutinous. This work is said to have resulted in a collection of 6,400 samples, which were divided into 751 groups of non-glutinous and 141 of glutinous. The figures give some idea of the magnitude of the task. These samples were then grown in pure-line culture for a series of years, and the permanence of the characters accurately determined. In this way it was found, as is generally the case, that apparently homogeneous samples were in reality composed of several very distinct types, and to obtain a thorough selection, one must begin with pure cultures. As an instance of what has been done by "pedigree" cultures, it is stated that from a variety called "Tranggerang" types have been isolated which yield 2·6 tons per acre (or over 74 maunds). It would be interesting to know whether this extraordinarily high yield has actually been obtained in field tests on a practical scale, or whether the yield is only that of small "pedigree" plots estimated to the acre, a very different thing.

There is an interesting paragraph on the popularization of the results. It is stated "In order that the results may be of immediate application to the cultivation of rice in Java, it is proposed to establish seed farms in several districts of the Island, since the results which have been obtained up to the present by a comparison of pure lines with one another only hold good for lands which are subject to the same conditions of climate, soil, and irrigation as the selection plots at Buitenzorg. It has on other occasions been

observed that some varieties of rice are very sensitive to changes in these conditions, especially as regards their time of ripening, yield, etc.; and it has rightly been remarked that figures of yield obtained at Buitenzorg ought not to be considered rigorously applicable everywhere. This has been fully understood by planters and they have begun on their own lands to cultivate plants for seed production in accordance with the system of isolation. The same method must be employed by the Government, if it desires to work in the interest of the native cultivator."

"In the seed farms, the cultivation of the varieties of rice which exist in the immediate neighbourhood and form the 'population' must be undertaken, then the culture in 'pure-line', which will lead to a selection of the better types, the seed of which will be subsequently distributed under certain conditions to the natives.

"The selection plots at Buitenzorg will afford the necessary information, but the aim of the Station will always be primarily the elucidation of the scientific side of the question of selection and the importation of new varieties from other countries."

Other paragraphs discuss the flowering of rice, the biology of the rice flower, mechanical selection and hybridization. In summing up, the following statement is made :—

"We have already seen that one must not remain content with selection only, but that seed farms must be instituted in order that the best use may be made of the results.

"From efforts which have already been made in this direction and which prove that the native cultivator is well able to appreciate the value of better seed, it may be expected that those interested in the cultivation of rice will follow with the closest attention, and will derive very great benefits from, these seed farms. It may be asked whether it is not sufficient to point out the way and to prescribe methods by which the cultivators may arrive at an improvement of the rice plant, by using better seed for example, and leaving to ordinary practice the task of applying the facts discovered.

"The answer to that is that the application of methods for the improvement of grain demands in the first place a knowledge of the

scientific principles on which the method is based, and therefore it is not a task which can be undertaken by anyone. And, secondly, as has already been proved in Europe, where the farmers in general have some knowledge of the principles of agriculture, the work of improvement of cereals demands so much attention and close control that it cannot be carried out in association with the ordinary work of cultivation."—(G. P. HECTOR.)

* *

BENGAL BEANS A NEW FODDER.—THE June (1914) number of the *Bulletin of the Department of Agriculture, Trinidad and Tobago*, has a note by Mr. Shrewsbury, Acting Government Analyst, on this subject. The beans received for examination were oval and rather flat, about $16 \times 10 \times 5$ m.m., with black shining testas and a white oblong crateriform hilum about 7 mm. in length. The Acting Director of Agriculture to whom the sample was submitted for botanical examination is inclined to call them *Stizolobium arterriimum*, but he doubts whether this is not a synonym for *Stizolobium utile* the *Mucuna utilis* of Wallich, which has been cultivated extensively in Mauritius and Tasmania as a table vegetable and as a fodder for cattle. As *Stizolobium niveum*, a closely related plant to *Stizolobium arterriimum*, causes vomiting and purging, and as *Stizolobium arterriimum* has not been known to be used for fodder or as human food, there were good grounds for suspecting the sample of toxic properties. But the search for cynogenetic glucosides by the method of Henry and Auld has resulted in no evidence of their presence. It is also reported that no evidence was found of other poisonous glucosides, saponins, fats, alkaloides, vegetable ptomaines or toxalbumins.

Several feeding experiments with guinea-pigs, in which the animals were fed with liberal quantities of the whole meal, the ground testas of the beans, the bean flour deprived of the testas, and various solvent extracts of the whole meal, are reported to have given entirely negative results. There was no indication of any toxic effect, the guinea-pigs exhibiting no abnormal symptoms, and their excretions continuing perfectly normal in character.

It is stated that the whole meal from the beans has a clean and pleasant appearance. The interior of the bean, which is easily ground, forms a very pale yellow powder, which is mottled by the shining fragments of the black testas. The taste and odour are pleasant and closely resemble that of pea-meal.

On analyses the Bengal bean has been found to be somewhat superior in feeding value to French, Lima, or Java beans and that like these beans its nutritive properties are principally due to the high content of carbohydrates and proteins. Owing chiefly to its low percentage of fat, its value is, however, considerably less than that of soy beans.

In conclusion the writer recommends caution in the use of these beans as a fodder, until their merits have been more firmly established. Tentative feeding experiments should therefore first be tried on animals of small value.—(EDITOR.)

* * *

THE July (1914) number of the *Journal of the Jamaica Agricultural Society* has a note on "preserving grain" from which the following extracts are made:—

" In recent years we have always used bi-sulphide of carbon for preserving grain from the attacks of weevils. It has some drawbacks, but is all right, when there are large quantities of grains to be kept and places well equipped with receptacles, such as bins, boxes, or even rooms which can be made *air-tight*, and so that a quantity of bi-sulphide can be purchased at one time ; also when there is some one responsible who can look after the treatment of the grain. But bi-sulphide does not suit the average man who may only want to keep comparatively small quantities of grain, is not well equipped with the places to store grain, and who is not likely to secure careful handling of bi-sulphide of carbon which is very inflammable.

" Before we gained knowledge of bi-sulphide of carbon we used naphthalene powder which, though not so suitable for preserving large quantities, is more suitable for small lots of grain,

and is easy to handle. The method of using naphthalene is just the opposite of that employed with bi-sulphide of carbon. The latter is a liquid gas heavier than air and when placed in a little tin on top of the grain in a close place, the gas from it sinks through the grain, killing all animal-life, but, unless used in great strength, does not interfere with the food or growing qualities of the grain. Naphthalene powder, on the other hand, is placed at the bottom of the grain, all that requires to be done is to put a pipe through it ; a bamboo, with the joints punched out so that it becomes a hollow tube, does very well. This is put in a box or barrel before the grain is put in so that it stands up with the grain around it. Naphthalene powder is dropped in this tube so that it goes to the bottom of the grain. Two teaspoonfuls of naphthalene powder will keep the grain in an ordinary flour barrel safe from weevils for about three weeks. The powder gradually evaporates and must be renewed when it is all gone, but evaporation is slow, taking about three weeks. If the grain is lying on the floor of a room where bi-sulphide of carbon cannot be used, naphthalene does fairly well. A hollow pipe and a dose of the naphthalene requires to be put down to every 10 feet square to be effective."—[EDITOR.]

* *

COMMON SALT AS A POISON FOR STOCK.—THE August (1914) number of the *Agricultural Gazette of New South Wales* contains a note on this subject written by Mr. Guthrie with a view to keep stock-owners and especially poultry-breeders and pig raisers on their guard against the danger of too great an admixture of common salt in the food, as several instances have recently been brought to the notice of the local Department, in which the deaths of poultry and pigs have been traced to this cause. Although a certain amount of salt is a necessary adjunct to the food both of human beings and of animals, certain kinds of animals are adversely affected by it when supplied in excessive quantities. The writer quotes Lander, "Veterinary Toxicology," 1912, in which it is said that in the case of pigs and sheep 4 to 8 oz.

has produced poisoning. In larger quantities it has proved fatal to horses, and even to cattle. Fowls would appear to be particularly susceptible. Suffran in his experiments with fowls has found that 4 grammes per kilo body-weight are fatal if injected in solution into the crop. The toxic effect of salt is reported to be apparently due to its action on the muscles, so that the animal becomes unable to walk and finally, to stand. Death is caused by asphyxia, due to loss of power in the respiratory muscles. It is therefore necessary to be cautious in this matter.—[EDITOR.]

* * *

The Agricultural Journal of Egypt, Vol. IV, Part I, has a short article on an experiment with the transplantation of rice on the Indian system conducted at Deirut (Rosetta). The experiment was carried out very carefully on 2 acres of land which was divided into equal plots, the object being to establish a comparison between the Egyptian system of broad-casting rice and the system of transplantation which not only gives an increased yield in India, but also by thickening and shortening the straw renders the crop less likely to be laid by wind. In Egypt while the cost of transplanting was higher as is the case in this country also, the yield on the other hand was only 55 maunds as against 81 maunds from the broadcasted plot. One advantage of the transplanting system found in Egypt was that it enabled an extra cut of berseem, valued at Rs. 33-13-0 to be taken from the unplanted field while the seedlings were in the nursery. But compared with the extra cost (about Rs. 10) of transplanting and the lower yield (a difference of 26 maunds—Rs. 109-13-0), this advantage is very small and it is reported that it does not appear to warrant the substitution of the Indian for the local system of planting in Egypt.—[EDITOR.]

* * *

The Journal of the Board of Agriculture, London (June, 1914), sums up as follows the facts in regard to the duration of the action

of manures investigated at Rothamsted, the particulars of these experiments having been published by Mr. A. D. Hall, M.A., F.R.A.S., in the *Journal of the Royal Agricultural Society* :—As regards farm-yard manure, the nitrogenous compounds introduced by the consumption of cakes and other concentrated feeding-stuffs have to be distinguished from the compounds derived from the straw and the undigested residues of such coarse foods as hay. The former will have an immediate effect on the first crop and to a much smaller extent on the second crop, after which they disappear, the latter compounds act slowly, do not waste, and have a measureable value for many years, though for practical purposes their action after the fourth year may be neglected. Among nitrogenous fertilisers ammonium compounds and nitrate of soda have no perceptible action after the first year. Peruvian guano, rape cake, and similar fertilisers containing proteins, leave very little residue after the first year and none after the second. On the other hand nitrogenous fertilisers of the wool, hair, and bone class are slow-acting and non-wasting, and their effect may be expected to persist for at least four years. Phosphatic fertilisers, even when soluble like superphosphate, do not waste in the soil and their residues continue to be effective until they have been exhausted in the crops.

* *

MIDLAND AGRICULTURAL AND DAIRY COLLEGE, ENGLAND.—The past two years have seen many changes and much activity in the development of agricultural education in England.

Under the Development Act, the funds at the disposal of the Board of Agriculture have been considerably augmented, and for their distribution a comprehensive scheme has been devised. Under this scheme, Provincial Agricultural Councils are set up ; the Agricultural Colleges, already established, are to be enlarged and strengthened in many respects, and the Board contemplate the formation of Farm Schools in many County areas.

The Regulations of the Board have required, moreover, the formation in each County of a special Agricultural Education Com-

mittee or Sub-Committee, and the appointment of an organizing officer whose business it shall be to organize and supervise all forms of agricultural education.

In this connection we have been favoured with a copy of the Scheme of Agricultural and Horticultural Education issued by the County Council of the parts of Lindsey, Lincolnshire, from which we reproduce the following prospectus of the Midland Agricultural and Dairy College.

The Midland Agricultural and Dairy College is situated at Kingston, in the County of Nottingham, and consists of fully equipped buildings and appliances for giving both theoretical and practical instruction in all branches of Agriculture and Dairying, whilst Horticulture, Apiculture, and Poultry Management are also dealt with, as far as they come within the scope of the ordinary farm.

The College was established by the co-operation of the County Councils of Derbyshire, Leicestershire, Nottinghamshire, and Lindsey Division of Lincolnshire, and is administered by a Governing Body consisting of representatives from these Counties. An annual grant is made by each of the Counties, and also by the Board of Agriculture, towards the cost of the Scheme of Education carried on at, and in connection with, the College.

THE COLLEGE FARMS.

The College is built in the centre of its own farm, 176 acres in extent, half of which is under permanent grass and half arable cultivation. Students are taken on to the farm for instruction, and are afforded every opportunity of making themselves acquainted with the system of farming followed and with the management of live-stock generally. Experiments are conducted on the manuring of different farm crops, and on the feeding of farm live-stock.

Since Lady-Day, 1912, another farm of 85 acres, situated at Sutton Bonington, about half an hour's walk from the College, has been acquired. This farm, which has a light gravelly soil, is

admirably suited for experimental work, and it is proposed to utilize it a good deal for this purpose.

COURSES AT THE COLLEGE.

TERMS.

Agriculture.

The Session is divided into three terms:—

- I. Term—October to December.
- II. Term—January to March.
- III. Term—March to May.

Students are thus able to be at home during the summer.

Dairying.

The Teachers' Diploma Course and the Factory Managers' Course is divided into two terms:—

- I. Term—October to December.
- II. Term—January to July.

Short Courses will be held all the year round.

The courses of instruction comprise:—

- (a) *Agriculture*.—A course in General Agriculture arranged in three Sessions of 10 weeks each, and carried on from October to May. A second year's course is provided for those desiring to take the National Diploma in Agriculture.
- (b) *Dairying*.—Courses in all branches of Dairying and Dairy Farming carried on all the year round. (Women Students attending these courses may also receive instruction in cookery.)
- (c) *Rural Economy*.—Rural Economy courses for Elementary School Teachers carried on during the summer holidays.
- (d) *Poultry*.—Six or twelve weeks' courses in poultry-keeping.

(a) AGRICULTURE.—*One year Course.*

The instruction in this course is given in three terms each of ten weeks' duration, commencing in October, January, and April.

| I. TERM. | II. TERM. | III. TERM. |
|--|---|---|
| OCTOBER TO DECEMBER. | JANUARY TO MARCH. | MARCH TO MAY. |
| Agriculture-Lectures and Demonstrations. | Agriculture-Lectures and Demonstrations. | Agriculture-Lectures and Demonstrations. |
| Veterinary Science. Agricultural Chemistry. Laboratory Work. Book-Keeping. Mensuration. Agricultural Engineering and Workshops. | Veterinary Science. Agricultural Chemistry. Laboratory Work. Book-Keeping. Agricultural Engineering and Workshops. Dairying. Entomology. Elementary Botany. Farm Calculations. Agricultural Economics. | Veterinary Science. Agricultural Chemistry. Laboratory Work. Book-Keeping. Agricultural Engineering and Workshops. Botany, Bacteriology. Land Surveying, etc. Dairying. Industries allied to Agriculture. |

The work which is taught in its most practical bearing, comprises Agriculture (both lectures and instruction on the farm), Veterinary Science, Book-keeping, Agricultural Chemistry, Wood and Iron Work, repairs to Farm Implements and the testing of Manures, Food-stuffs, Seeds, etc.

This course qualifies for the College Certificate in Agriculture.

Arrangements have been made with the Yorkshire Council for Agricultural Education, whereby students requiring a longer course of instruction than is provided at the Midland Agricultural and Dairy College may go through the three years' course at the University of Leeds.

(b) DAIRYING.

The object of the College is to provide a thoroughly practical course of instruction in dairying, combined with such scientific instruction as is found necessary to explain the principles on which the practice depends. The production of milk, and the causes

influencing such production ; milking, treatment of milk for transit, methods of creaming, separating, butter making, cheese making, with the best methods of packing and marketing, are the subjects taught. The instruction in practical and theoretical cheese making may include any or all of the following varieties of cheeses : the various kinds of English cheese (Cheddar, Stilton, Derby, Leicester, Trent-side, Cheshire, Wensleydale, etc.), and of the foreign varieties (Gorgonzola, Brie, Camembert, Gruyère, Edam, Port du Salut, Pont l' Eveque, etc.). Accurate records of all work done are kept by the students. Students are expected to spend the greater part of the day in the actual practical work.

The instruction in dairying is divided into three classes :—

- (1) Short Courses.
- (2) Teachers' Diploma Course.
- (3) Factory Managers' Course.

(1) Short Course.

The course for this class extends over a period of six weeks (except the two courses before Christmas, which are of five weeks' duration), and includes instruction in the following branches :— The composition, properties, production and manipulation of milk, cream, butter, soft and hard cheese (not more than two kinds of the latter should be attempted in the six weeks' course), milk record keeping, milk testing, separating, cream ripening, influence of ferments and bacteria on milk, butter, and cheese ; making up and packing of butter ; the general management and common ailments of dairy stock.

The greater part of the time is spent in practical work in the dairy and in class work in dairying, the remainder of the time being taken up with laboratory work in milk testing and lectures on Veterinary Surgery, chemistry of milk and its products. In the Six Weeks' Course one week's practical instruction is in cooking.

A Certificate is granted if the work has been satisfactorily performed and the examination passed.

Practical Dairying each morning throughout the course.

(2) *Teachers' Diploma Course.*

Students entering this course must attend for a period of not less than nine months, commencing in October, if they wish to obtain the Teachers' Diploma granted by the College.

(3) *Factory Managers' Course.*

Is intended for those requiring a commercial knowledge of Dairying or Factory management, such as Dairying in a large way of business, Factory managers, and intending colonists.

POULTRY-KEEPING.

One special course of instruction in Poultry-keeping is held in each year, for those desiring to gain a thorough knowledge of all branches of the subject, and to prepare themselves for the examination for the College Certificate in Poultry-keeping.

The course is of twelve consecutive weeks' duration, and commences at the same time as the third Agricultural term (April).

FEES FOR INSTRUCTION.

Dairy Courses.—For students residing in Lindsey.

10/- per week up to 12 weeks.

9/- per week for each week over 12 up to 18 weeks.

7/6- per week for each week over 18 weeks.

Poultry Course.—Same as for Dairy courses.

Agricultural Courses.—£5 per term of 10 weeks.

Board and Lodging as follows :—

Men, 15/- per week ; Women, 12/- per week.

Washing not included.

Free scholarships and studentships for all courses are awarded.

REVIEWS

The Controlling Influence of Carbon Dioxide in the Maturation, Dormancy, and Germination of Seeds.—PARTS I & II. FRANKLIN KIDD. *Proc. Roy. Soc.*, B. Vol. 87, 1914.

THE delayed germination of seeds is a well-known phenomenon and cases abound in the literature on agricultural subjects. The causes of this latent condition have, however, remained obscure until the paper under review appeared during the present year. The author has shown that the presence of carbon dioxide in the embryo itself is the main cause of delayed germination in resting seeds and he sums up his final conclusions as follows :—

“(1) The resting stage of the moist seed is primarily a phase of narcosis induced by the action of carbon dioxide.

(2) Both the arrested development in the case of the moist maturing seed on the plant, and the widely occurring phenomenon of delayed germination in the case of the moist resting seed, which does not germinate although in apparently suitable conditions of temperature, moisture, and oxygen supply, are related to an inhibitory partial pressure of carbon dioxide in the tissues of the embryo.

(3) Germination when it takes place is related to a lowering of the value of this inhibitory partial pressure of carbon dioxide in the tissues.

(4) The inhibitory value of a given carbon dioxide pressure diminishes with a rise of temperature.

(5) The inhibitory value of a given carbon dioxide pressure diminishes with a rise of oxygen pressure.”

During the progress of this investigation, two interesting points of agricultural interest were dealt with. In the case of seeds of white mustard, planted in soil at various depths over decaying grass, it was found that germination was entirely inhibited due to

the high percentage of carbon dioxide in the soil gases. The author suggests that these results show that caution is necessary in placing seed in the ground into which green crops have been ploughed or which has been recently heavily manured. Two instances of poor germination after green-manuring occurred at Pusa in 1913, when seed was sown soon after a green crop of *sanai* (*Crotalaria juncea*, L.) was ploughed in. In one case, a portion of a tobacco nursery was green-manured on July 15th, the tobacco seed being sown on August 19th, thirty-five days afterwards. The germination was exceedingly poor in comparison with normally treated areas and this portion of the nursery practically failed. In the second case, Java indigo was sown thirty-three days after *sanai* was ploughed in, with the result that the crop was very thin in comparison with the control plot.

The second point of direct agricultural interest, referred to in this paper, relates to the seeds of Para rubber which, as is well known, rapidly lose their germinating power. In planting this seed under estate conditions, it is always desirable to put the seed in the ground within a fortnight. On this account, some practicable method of extending the life of these seeds is most desirable. The author found that sealing up the seeds with air in flasks gave far better results than the commercial method now in use of packing these seeds in a mixture of charcoal and ashes. He suggests that sealing up the seeds with the proper proportion of air in large carboys might be tried in practice as by this means the partial pressure of carbon dioxide, which was found to inhibit deterioration in the experiments, could be employed as a preservative agent.

From the point of view of Indian agriculture, Mr. Kidd's investigations suggest a line of work in connection with green-manuring which is almost bound to yield useful results. Experiments on this subject at Pusa¹ show conclusively that green-manuring for cold season crops only gives positive results on light, well-drained soils when the interval between ploughing in the green manure and planting the next crop is about eight weeks. On heavy lands or on lands which are waterlogged from any cause,

¹ *Agr. Jour. of India*, Vol. VII, 1912, p. 79; and Vol. IX, 1914, p. 197.

green-manuring leads to a smaller crop than that on control plots. Shortening the time between ploughing in the green manure and planting the next crop gives reduced yields similar to those on heavy or waterlogged land. That these results are, in all probability, connected with the supply of oxygen in the soil is suggested by the effects obtained last year at Pusa in subsoiling after green-manuring. Three plots were green-manured with *sanai* on July 15th, August 8th, and August 28th, respectively. On September 24th, a strip down the middle of these plots was subsoiled to a depth of about twelve inches, two days before the tobacco was transplanted. The arrangement of the plots is shown in the following diagram:—

Green-Manuring Experiments at Pusa in 1913.

| PLOT 1. | PLOT 2. | PLOT 3 |
|--|---------------------------------------|---------------------------------------|
| SHADED STRIP SUBSOILED ON SEPTEMBER 24 th | | |
| GREEN-MANURED JULY. 15 th | GREEN-MANURED AUG. 8 th | GREEN-MANURED AUG 28 th |

The results of the experiment were very striking. The tobacco in plot 1 grew very rapidly from the beginning and gave the best results. Plot 2 was not so good while plot 3 was poor. In plots 2 and 3 particularly, subsoiling gave a considerable crop increase and the appearance of the tobacco on this strip suggested a liberal dressing of nitrogenous manure. The subsoiling would have released a portion of the carbon dioxide in the soil which had accumulated as a result of the green-manuring and would also have directly increased the supply of oxygen. Possibly the extra air supply not only influenced the final stages in the nitrification of the decaying organic matter but also increased the supply of air for the roots of the tobacco crop. The changes in the soil gases following green-manuring under Indian conditions obviously require to be investigated and the results are almost certain to prove of interest. Besides the time factor, it is exceedingly probable that thorough cultivation after

the green crop has for the most part disappeared will be necessary if optimum results are to be obtained. The large amount of carbon dioxide resulting from the decay of the green crop will probably have to be got rid of and as much oxygen as possible introduced into the soil before the next crop is sown. Field experiments on this point are now in progress in the Botanical area at Pusa.—(A. H.)

* * *

Present state of the Dairying Industry in Bombay.—By J. B. KNIGHT, M.Sc., Professor of Agriculture, and E. W. HORN, Manager, Government Civil Dairy. Bulletin No. 56 of the Department of Agriculture, Bombay. Price 3 annas or 3 pence.

THIS bulletin deals concisely with the dairy industry in Bombay as it stands at present and gives an idea of what may be done to make much needed improvements in every direction.

The milch cows of the Presidency together with the four types of buffalo chiefly used are reviewed and criticized, and "grading" is advocated as the best method of improvement; selection from local stock being regarded as best left to local breeders, on account of the length of time required to produce any improvement. The authors favour the introduction of bulls of considerable value and deprecate the present method of importing moderate bulls. They however pass too lightly over the risk of disease, taking into consideration the difference between a price of Rs. 6,000 and one of Rs. 600, when one loses an imported bull at the end of 3 months in the country, and, as there can be little doubt but that most of the English 'Dairy' breeds are considerably more liable to disease than the dual purpose animal, it would seem that this question waits on the Veterinary Department for a satisfactory solution. The questions of feeding and housing are dealt with, both of which problems are at present governed by the fact that an enormous number of cows are required to produce as much milk in India as a vastly smaller number would give in England and by the number of "wasters" who fail to "pull their weight" in the herd, but must be kept on because the supply of good cows is getting smaller every year. It is only to be expected that "Suburban

Dairy Farming" with its attendant evils, which has made, and is making, such appalling drains on the best milch cattle of England, is in full swing in Bombay, and it would seem out here that if it is allowed to go on it will effectually counteract any attempts to improve the milch cattle or to lower the price of milk, as it has begun at an infinitely earlier stage than it did in England.

The bulletin after dealing with separating stations and creameries and other works of national importance ends up with an exhortation for cleanliness all along the line, which might with advantage have come first on the principle that it is useless washing your hands after you have milked the cow.

In conclusion one is left with the impression that the milk problem is about to be solved in several ways, but in which way it will be, depends on (1) whether the Veterinary Department stamps out disease; (2) whether the breeder selects up the local stock; (3) whether the agriculturist settles the fodder problem. The first of these three to complete his task will solve the milk question along his own lines of work.—(W. S.)



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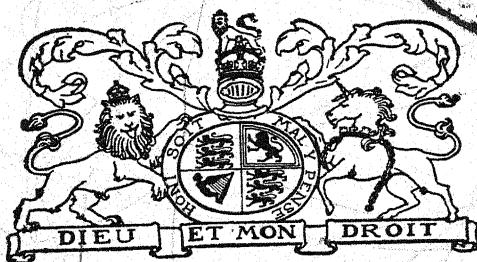
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VOL. X, PART II

QUARTERLY

APRIL, 1915

THE
AGRICULTURAL JOURNAL
OF INDIA



AGRICULTURAL RESEARCH INSTITUTE, PUSA

PUBLISHED FOR
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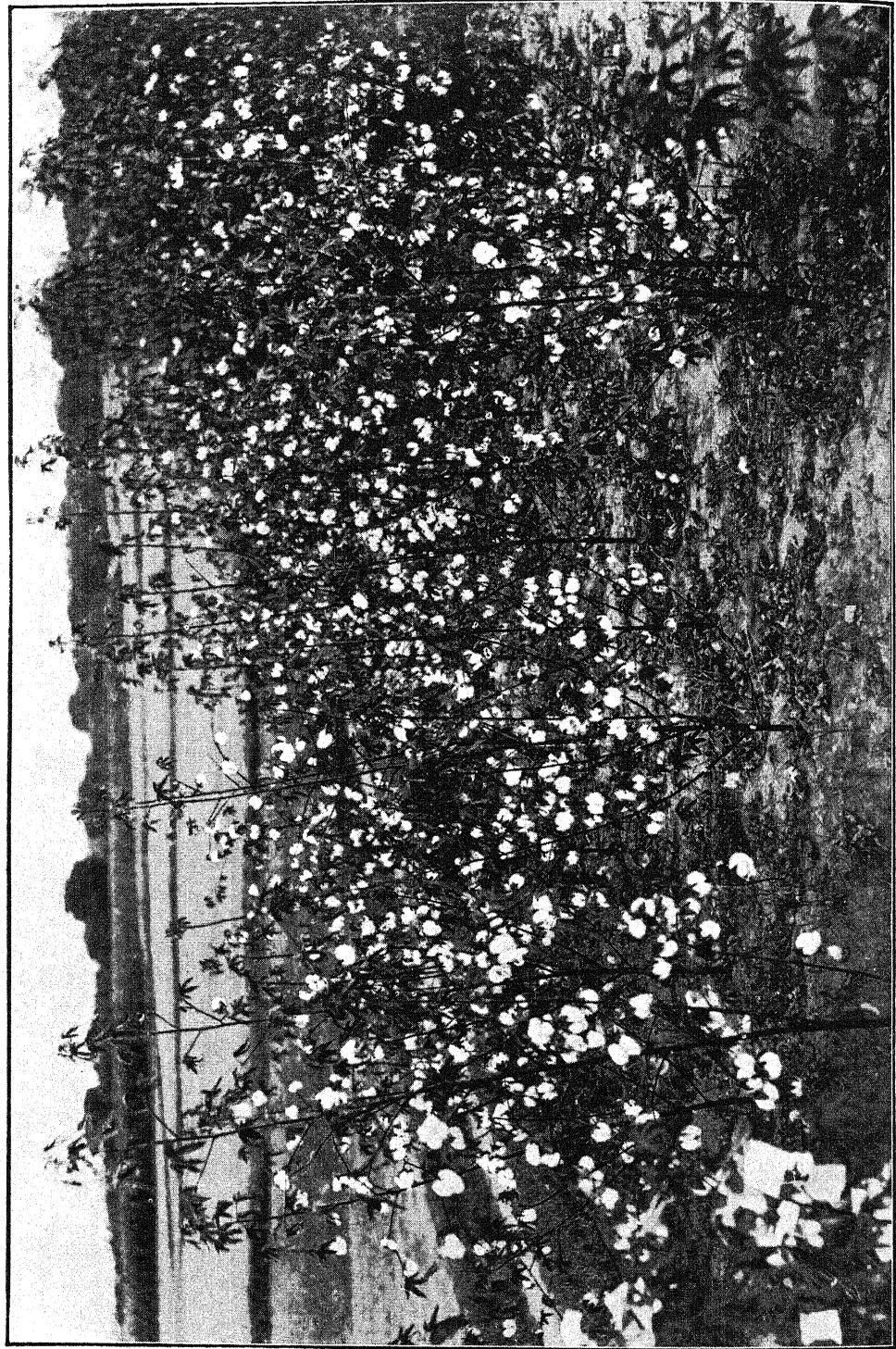
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CONTENTS

| | <i>Page</i> |
|---|--|
| THE BREEDING OF IMPROVED COTTONS IN THE UNITED PROVINCES | <i>H. Martin Leake, M.A.</i> ... 111 |
| THE CONTROL OF <i>Koleroga</i> OF THE ARECA PALM, A DISEASE CAUSED BY <i>Phytoph-</i> <i>thora Omnivora</i> VAR. <i>Arecæ</i> ... | <i>L. C. Coleman, M.A., Ph.D.</i> ... 129 |
| RECENT HISTORY OF THE COTTON IMPROVE- MENT WORK IN TINNEVELLY AND RAMNAD DISTRICTS | <i>H. C. Sampson, B.Sc.</i> ... 137 |
| COTTON IMPROVEMENT IN BERAR ... | <i>D. Clouston, M.A., B.Sc.</i> ... 148 |
| LOCUSTS IN BALUCHISTAN ... | <i>Lt.-Col. F. C. Webb Ware, C.I.E.</i> ... 159 |
| SECOND REPORT ON THE IMPROVEMENT OF INDIGO IN BIHAR ... | <i>Albert Howard, C.I.E., M.A., and Gabrielle L. C. Howard, M.A.</i> ... 167 |
| NOTES ... | 180 |
| REVIEWS ... | 196 |
| LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1ST AUGUST, 1914, TO 31ST JANUARY, 1915. | |

A FIELD CROP OF ONE OF THE CROSS - BREED RACES REFERRED TO UNDER (4).

PLATE VI.



THE BREEDING OF IMPROVED COTTONS IN THE UNITED PROVINCES.

BY

H. MARTIN LEAKE, M.A.,

Economic Botanist to Government, United Provinces.

IN two previous publications¹ the writer has, in collaboration with Dr. Parr, attempted to indicate the lines along which the improvement of the indigenous cottons of the United Provinces has been, and is being, developed. In these emphasis was laid on the results which were at the time bearing practical fruit, and the more detailed work which the writer has been carrying out for a series of years was only dealt with in the briefest outline. In the succeeding pages an attempt will be made to show, in greater detail, both the nature of this latter work and the manner in which the economic aim, that of evolving a plant capable of extended culture in the United Provinces and which will yield a higher money return to the cultivator than that at present cultivated, is being kept in view.

"Failure is less frequently attributable to either insufficiency of means or impatience of labour than to a confused understanding of the thing actually to be done."² This statement is applicable to lines of study other than art, of which it was originally written, and nowhere is its truth more valid than in attempts, like the present, to attain practical results through the medium of theoretical considerations. We must "know what we have to do and do it"—in other

¹ *Agricultural Journal of India*, VI (1911), p. 1; and VIII (1913), p. 47.

² Ruskin. "The Seven Lamps of Architecture."

words, we must in the present case visualise the ideal plant, and, from the material to hand, in the shape of the various forms at present cultivated, set out to produce it. Thus only will success, if it be possible at all, be attained. The first consideration, then, is to picture, in as great detail as possible, the "ideal plant"—that type of plant which is most suitable for cultivation in these provinces. What that type is, is so intimately bound up with the economic and climatic conditions under which cotton cultivation is conducted that the writer may be pardoned for re-iterating what has already been outlined in the two papers referred to.

In the first place, the plant must be early maturing since the marked cold weather, prevalent in the cotton growing tracts in these provinces, is sufficiently intense not only to check growth but to cut back the plant. Thus a definite ultimate time limit is set to the period of growth. An equally sharp initial time limit for fruit production is set by the rainy season, before the end of which no cotton of commercial value is produced. The season of cotton production is, therefore, sharply demarcated, and an early maturing plant alone satisfies these conditions. Such are the limits imposed by climatic conditions.

We may now consider the economic conditions. These are more complex and will require more detailed consideration. The ultimate factor controlling the cotton production is the money return from a unit area of land under the crop. The cultivator is free to choose what crop he will grow, and will devote the balance of his land, after he has provided for the needs of himself, his family and his cattle, to that crop which appeals to him as most remunerative, subject to such limitations as are involved in the maintenance of the customary systems of rotation, which involve a distribution of land between *rabi* and *kharif* crops. Such considerations are, however, of small interest here. The cultivator has already struck his balance and the resultant of such economic forces is to be found in the area under cotton in each particular tract. The problem is to increase the value of a unit area of cotton as compared with the value of such an unit under the type, or types, now under cultivation.

Such increase may arise from two sources, either outturn may be enhanced—an improvement due to quantity—or the value of the produce may be increased through an improvement due to quality. Still further benefit will be derived from a simultaneous enhancement of both factors. We are here concerned with two distinct aspects. The first of these is purely agricultural, the second involves a knowledge of the markets and their needs. These two aspects may, therefore, be considered independently, and it is proposed to discuss them here only so far as is sufficient to indicate those plant characters which require special attention from the practical aspect.

The consideration of quantity or outturn is, in some measure, complicated by the fact that the cultivator reaps, and disposes of, his produce as *kapas* or seed cotton. The purchaser fixes the price very largely by the amount of *rui*, or lint, which that *kapas* will yield. The price realized by the cultivator is, therefore, controlled by—

- (1) The actual yield of *kapas*, and
- (2) The percentage of *rui* in the *kapas*—the ginning percentage.

Under the limits imposed by the climatic conditions *kapas* yield is very largely controlled by the habit of the plant. The ginning per cent. is, on the other hand, a character of the plant, unaffected or scarcely affected, by climatic conditions.

Yield may also be affected by the size of the fruit or boll. The number of bolls, which will later be shown to depend very largely on the habit, being constant, it clearly follows that the larger the boll, the greater will be the yield. Our consideration of the agricultural aspect, therefore, indicates three points which must be borne in mind in the evolution of the ideal plant. These are—

- (a) Habit.
- (b) Ginning percentage.
- (c) Size of boll.

The question of quality is still more complex—a complexity due partly to the fact that the markets are highly organized and fluctuating. Moreover, they are, to a large extent, independent and

do not always move sympathetically. Broadly speaking, they may be divided into two—the one, centralized in Lancashire, using long staple cottons, the other, including the Continent and the East, chiefly requiring cottons of short staple. The chief source of long staple cotton is Egypt and America and of the short staple India and the East generally. The source of supply being thus widely separated, it is not surprising that we find a year of shortage, and consequently high price, in the one is sometimes a year of full supply and low prices in the other. Consequently conditions can easily be imagined when the inferior, may be a more remunerative crop than the superior, quality. Such cases are, however, exceptional. The cultivator has to look to the main chance and in the average the better the quality, the greater will be the value.

When, however, we come to consider the meaning of the term quality we are faced with considerable difficulty. The trade is highly technical with a terminology of its own. The terms are ill defined and for their thorough understanding a long apprenticeship would be required. Nevertheless certain features are outstanding and these may be shortly detailed.

Broadly speaking, the degrees in quality are determined by the fineness of the thread that can be spun, though here again we have to distinguish between two types of thread—the warp and the weft. For the production of a fine thread certain essentials are necessary. In the first place, we may cite length, for, the longer the individual fibre, the less will be the chance of several ends occurring at a particular spot in the thread and of the formation of a point of weakness where breakage of the thread is likely to occur. Length of fibre will help to an even distribution of strain. For a thread to break, however, it is not necessary that the individual fibres should rupture. Rupture of a thread probably is rarely initiated in this way. Most frequently it results from the drawing apart of interlocking fibres. In other words, the strength of a thread at any point is not given by the sum of the breaking strains of the individual fibres of which it is composed at that point ; it is considerably less than this figure. Two points emerge from this consideration. The first of these is the nature

of the force which binds the fibres together. The process of spinning consists firstly of rendering the fibres parallel and then twisting them to form a thread. The retention of that twist, however, is due largely to the natural twist of each individual fibre, which causes these to interlock—such natural twist is, therefore, a matter of the utmost importance. Secondly, it is clear that the larger the number of the interlocking fibres, the greater will be the force required to pull them apart, or, given the diameter of the thread, its strength at any point will, within limits, increase with the number of fibres of which it is composed at that point. Fineness of fibre is, therefore, a point of much importance.

The three main qualities, which, from the consumer's aspect, have to be taken into account are—

- (d) Length of fibre,
- (e) Twist of fibre,
- (f) Fineness of fibre.

Further points, from the spinner's point of view, are of importance, though this importance is secondary from the aspect of the plant breeder. Here only three may be mentioned—

- (g) Colour,
- (h) Uniformity,
- (i) Nep.

Our ideal plant may, therefore, be defined as one which possesses, as its more important characters, an early maturing habit; a profusion of large bolls; a high ginning percent; a long, fine, uniform fibre possessing a good natural twist; a good colour and freedom from nep. The production of such a plant, or plants, is the ultimate aim of the work which has now been in progress for some years and an attempt will here be made to show, not only the degree of success which has been obtained in approaching this ideal, but also the evidence there is that such a plant is obtainable—for it is conceivable that some pair of these desirable characters might be mutually exclusive. What is meant by two characters being mutually exclusive can best be illustrated by a reference to the generally accepted idea that length of staple in some way is associated with the growing period of the plant. This idea has found

tentative expression in a recent publication¹ where the following remark occurs: "Length of staple appears to be connected in some way with length of growing season—at any rate no long-stapled cotton has yet come into general cultivation in any district where the normal development of the plant is interfered with by cold at one end of the season and excessive heat and drought at the other. It is probable, however, that this is a coincidence, and that it may eventually be possible to combine earliness and length of staple with a fine yielding power in one plant." In this connection we have first to consider what is meant by the terms "long" and "short" staple. At one extreme of the cottons of commerce lies the Sea Island Cotton with a staple of over 2 in.; at the other lie the inferior Bengals, with a staple of about $\frac{1}{2}$ inch. Between these extremes lie a number of forms, giving an almost complete gradation, and the delimitation of short and long-stapled forms becomes largely a matter of personal choice for which no hard-and-fast definition exists. Practically, however, such a delimitation can be given. Reference has already been made to the Lancashire markets as long staple and to the Continental and Eastern markets as short. Broadly speaking, this distinction holds and the question, therefore, resolves itself into one of the possibility of producing an early maturing plant having a staple at least equal to middling Americans, which we may accept as the standard of the Lancashire market. The answer to this, and similar questions as to linkage between different characters will be given later, after fuller information concerning the characters concerned has been acquired.

(a) *Habit*.—As has been stated above, the ideal plant must be early maturing or the yield will be low. The dependence of the length of the vegetative period on the type of branching has, on so many previous occasions, been indicated that this point need not be laboured here. Briefly, the main stem of the cotton plant produces two types of branches—the vegetative and the reproductive. The initial branches, those nearest the ground, are almost invariably vegetative while, higher up the stem, this type of branching

¹ *Report on the Progress of Agriculture in India, 1912-13.*

may give place to reproductive branches. Clearly, the sooner such replacement takes place, the earlier will the plant begin to bear flowers. The type of branching is a point of primary importance in the consideration of habit. Unfortunately, for simplicity's sake, it is not the only point. Certain types of plant occur in which only a small number of vegetative branches arise at the base; above these, branches of the reproductive type are produced but these remain small, and, if buds are produced on them, these buds do not develop into mature fruits. The vigour of the plant is absorbed by the main stem and the few vegetative branches which become long and woody. Such a type cannot produce a commercial crop, and we have to take into consideration a second point, namely, the direction in which the vigour of the plant is diverted. The ideal habit for a plant is one in which the lower branches are vegetative and of moderate growth while the upper are reproductive and vigorous.

(b) *Ginning percent.*—The ginning percent of the cottons under general cultivation varies from 30—33 and this figure may be accepted as the standard in considering the question of improvement. During the past few years Dr. Parr has isolated a type of cotton, whose cultivation has spread rapidly in the western districts of these provinces, of which the ginning percent is 40—41, and for the *kapas* of this the cultivator receives a relatively enhanced price, a fact which has to be taken into consideration in deciding whether a new form is a sufficient improvement to justify introduction to the public. The direct relation existing between the ginning percent and the price realized by the cultivator for his *kapas* lends additional import to this figure, and the question of ginning percent has received on this account much detailed attention. The problem is no simple one, but sufficient has been learnt to render it probable that the production of a plant showing a high figure for the ginning percent will no longer be the purely speculative matter it has hitherto been. It is not possible to go into details here; those that desire fuller information on this subject may refer to the present writer's paper dealing with this point¹. Briefly, it has been shown that the ginning

¹ *Journal of Genetics*, IV (1914), p. 41.

percent depends mainly on the number of fibres arising from a single seed and, to a lesser degree, on the size of the seed and weight of the individual fibres. With this knowledge it is hoped to produce, by suitable combinations, plants with a ginning percent much above the present standard.

(c) *Size of boll.*—The size of the boll is very variable as the following figures for the weight of *kapas* from individual bolls indicate. At one extreme lie the types with small bolls with a *kapas* weight of 2 g. or less; Broach, *nurma* cottons and others. At the other extreme lies *G. cernuum*—the Garo Hill cotton—with a *kapas* weight as much as 5 g. Between these extremes lie the common cottons of cultivation with a *kapas* weight of 2·5 g. to 3 g. Clearly here there is a range sufficient to make a large difference to the crop yield, supposing the number of bolls to remain constant. The size of the boll is, in a large measure, determined by the number of seeds, the smaller bolls having 7 to 8 per cell—21-24 in all, the medium 8-10, and the largest, those of *G. cernuum*, 13 to 15. It must not, however, be thought possible to double the size of the boll without influencing in some measure their number. The physiological processes of the plant set a definite limit to the production of the food material necessary to nourish the developing embryos, a fact which receives practical demonstration in the length of the fruiting season. With the production of the maximum number of bolls the plant is capable of developing, flowering ceases; consequently the large bolled-forms have a comparatively short season. Nevertheless, it appears probable that reduction in number is not strictly proportional to the increase in size of the fruits, and that considerable advantage will arise from increasing the size of boll not only through the direct increase in yield but in the number of pickings and in the ease of picking a few large, as compared with many small, aggregates.

(d) *Length of fibre.*—The determination of this character is a matter of considerable difficulty. The cotton buyer has evolved a practical method which is most efficient in answering his purpose. It is not, however, suited to the plant breeder who has to take into account the differences between plant and plant. The cotton plant

produces fibres throughout a considerable period, 2-3 months, and under most diverse conditions. As the season proceeds, the moist, and hot, conditions change to dry, and cold. It is not surprising, therefore, that considerable differences in length of fibre are found in samples gathered from a single plant at different seasons. It is further demonstrable that the fibre length varies not only from seed to seed in the boll but even from different parts of the same seed.¹ For the purposes of plant breeding measurements must be comparative and the samples, therefore, must be taken so as to eliminate such variations as far as possible.

Such guarded determinations show the length of fibre of Indian cottons varies from 12 mm. to 30 mm. or over.²

Of the former length are some of the poorest forms of Bengal cottons. The latter length is approached only in such cottons as Broach, *nurma* and *bani*. Much of the American type of cotton has a staple ranging from 25 mm.—30 mm., so that among the Indian cottons we have the range of fibre length necessary to produce a long staple cotton.

(e) *Twist of fibre*.—During the ripening process, after the fruit has opened, the individual fibres lose their moisture, take on a more or less flattened form and become irregularly twisted on their axis in a spiral manner. It is this twist which causes the fibre to grip in the thread. As far as the writer has been able to observe, none of the cottons with which we are concerned suffer from lack of twist—probably the danger lies rather in the presence of an excess.

(f) *Fineness of fibre*.—A large range of variation in this character is found in the Indian cottons, and here, again, the chief difficulty has been met in obtaining a practical method for measuring "fineness." The common methods of direct measurement of breadth are unsatisfactory for the fibre is not, in the first place, round, and in the second place, sufficient determinations to obtain a true average

¹ Yves Henri. *Determination de la valeur commerciale des fibres du coton.*

² A mm. standard here is purposely adopted in preference to an inch standard. The measurements are comparative only, and it does not necessarily follow that 25 mm. (1 in.) fibre length would give a sample which commercial determination would denote as of 1 in. staple.

would be beyond practical possibility. The figures adopted here indicate the area of cross section of 1,000 fibres. The range of fineness thus determined has been found to vary from 0·5 sq. mm. in the case of coarse Bengals, to 0·13 sq. mm. in the case of *bani* cotton. The latter figure is the same as that found for Upland American cotton while a sample of Egyptian cotton alone, of those tested, proved to be finer, with a figure of 0·12 sq. mm. Thus we have, among the Indian cottons, races which equal the fineness of the Upland American.

(g) *Colour*.—There is no better way, in dealing with this somewhat elusive character than to quote the words of Mr. McConnell.¹ “But for the most part colour is chiefly important as an index to quality. The buyer of cotton yarns is suspicious of the quality if the colour is changed, but when once he is satisfied that the quality is right, a new shade, whether lighter or darker, generally becomes as acceptable as the old.”

From this it would appear that, though price is undoubtedly paid for colour,² it is rather as an indicator of quality than for its intrinsic merit. Being a character that is with difficulty determinable except in bulk samples, it is not possible to breed for colour. Practically, however, little difficulty has been incurred in maintaining a good colour.

(h) *Uniformity* or the evenness of staple length. Lack of uniformity, as it is understood commercially, is most commonly due to race mixture in the field. Such lack of uniformity is at once removed by the cultivation of pure races. Such evidence as we have seems to indicate that the uniformity of a pure race is far in advance of that found in any commercial sample. Where it has been detected in our samples it appears to be due to the admixture of successive pickings which the comparatively small areas, and the desire for a bulk sample, rendered necessary. Grown on the commercial scale when the successive pickings would be harvested separately, this cause of lack of uniformity will, in all probability, be found to disappear.

¹ *Textile Mercury*, March 21st, 1914.

² Leake & Parr. *Agricultural Journal of India*, VIII (1913), p. 47.

(i) "Nep," "Refraction," etc.—Under such terms are included all losses in the process of spinning represented by the difference between the weight of cotton taken and the weight of yarn obtained. Such losses occur at different stages and have a different origin. In the blow room the chief loss is due to the removal of dirt and extraneous matter such as leaf. The extent of loss will depend very largely on the care expended in picking but to a certain degree on the extent to which the boll opens and exposes the cotton. In this character the Indian cottons differ considerably.

The second loss is in the carding process, during which the weak, short and immature fibres are largely removed. There appears to be no evidence to connect this loss with the character of the plant. It is, rather, traceable to external conditions such as poor cultivation, unfavourable climatic conditions, leading to disease, and such causes. As such, it has little bearing on the plant breeding aspect of the question.

So far an attempt has been made to outline the main characteristics that an ideal plant should have, and we may pass on to a consideration of the material available for the production of such a plant.

The bulk of the cotton grown for commerce in the United Provinces comes from a mixture of races which pass under the name of *G. neglectum*. Many of these races have a good habit and in some instances the ginning percent is high. As a body, however, they are characterized by a short and coarse staple which makes their lint suited for the lowest counts only.

Throughout the provinces are to be found in scattered places a few plants of the *nurma* cotton, *G. arboreum*. The lint of this is the best found in the provinces. It is fully 1 inch in length and moderately fine. The plant, however, is totally unsuited for cultivation by its habit, which is perennial, while the ginning percent of the *kapas* is low.

The only other plant found in these provinces is the *radhiya* cotton of the Eastern districts—*G. intermedium*—a plant conspicuous for its lack of every desirable characteristic. The plant does not fruit till the succeeding hot weather, the lint is short to medium while the ginning percent is 15 only.

Passing to the extra provincial cottons, we have, in the central portions of India, the *bani* cotton. This plant has the finest lint of any cotton examined by us and is of good length. The plant is not, however, robust and the yield is light while the ginning percent is low. The disadvantageous, outweigh the good, qualities, and the growth of this plant, in its present form, does not prove remunerative. This is shown by the way in which it is being replaced by a coarse lint plant in the Central Provinces.

In Bombay the Broach cotton is largely cultivated. This, again, is a late flowering plant, useless for cultivation in the United Provinces. It has, further, in crossing, been found to develop considerable sterility and is, therefore, of little use for the purpose of breeding.

Lastly, we may mention the Garo Hill cotton, *G. cernuum*. This plant is of a robust and early habit with a high ginning percent and a particularly large boll. The lint, however, is too short and coarse to be spun, except into the coarsest of yarn.

The remaining forms of Indian cottons need not be described here, since they have, for one reason or another, proved unsuitable for breeding purposes.

A comparison of the ideal plant, as already outlined, with any of the above known types will disclose in each case an absence of several desirable features in them, and the breeding problem is to combine the desirable features of these plants into a single individual.

The ideal habit has been found in a single plant only—a variety of the common *desi* plant *G. neglectum*.¹ It is early in maturing and bears vigorous fertile branches in profusion. The lint, however, is little better than that of the *desi* mixture, the ginning percent is practically the same and the boll is small. This plant, pure cultures of which are being distributed under the number K 7 in Bundelkhand, for which its early habit renders it peculiarly suitable, must form the basis of the ideal plant it is desired to obtain.

¹ This description has been allowed to stand as it has been used by the writer in previous papers. The plant, however, is more probably a variety of *G. indicum*.

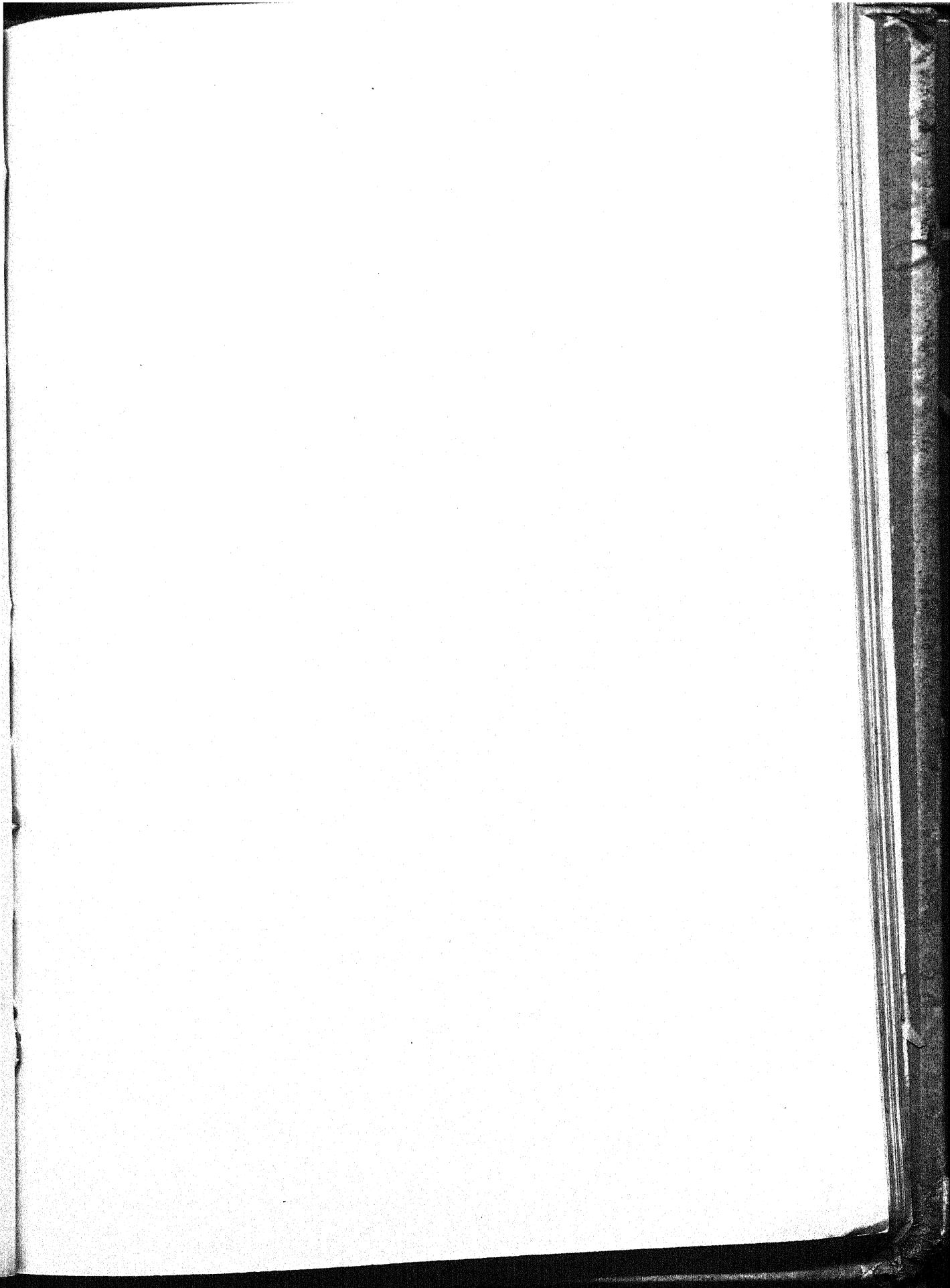


PLATE IV.

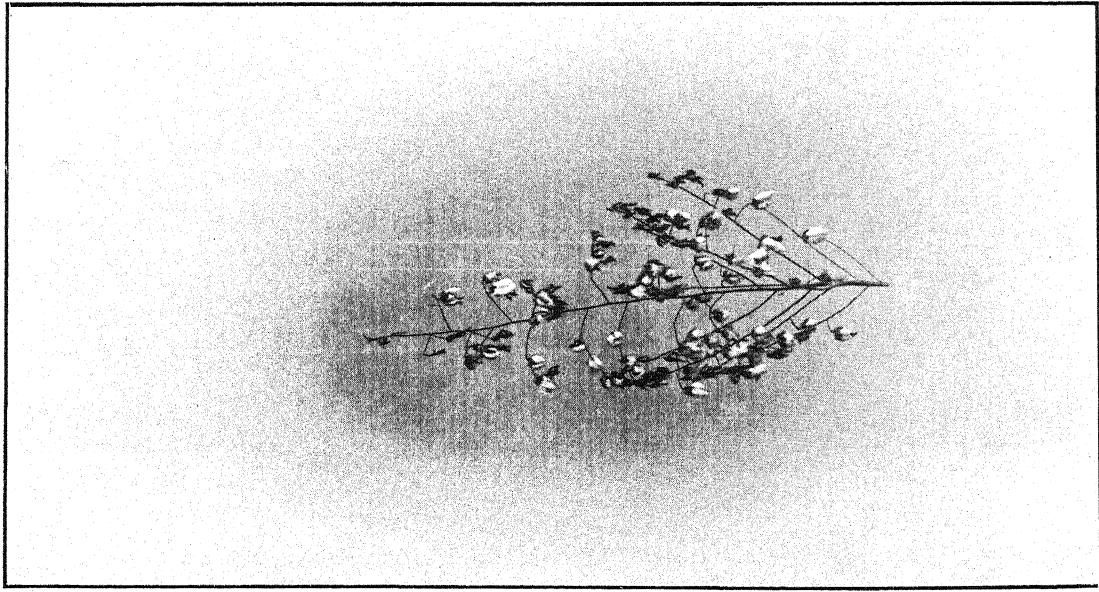
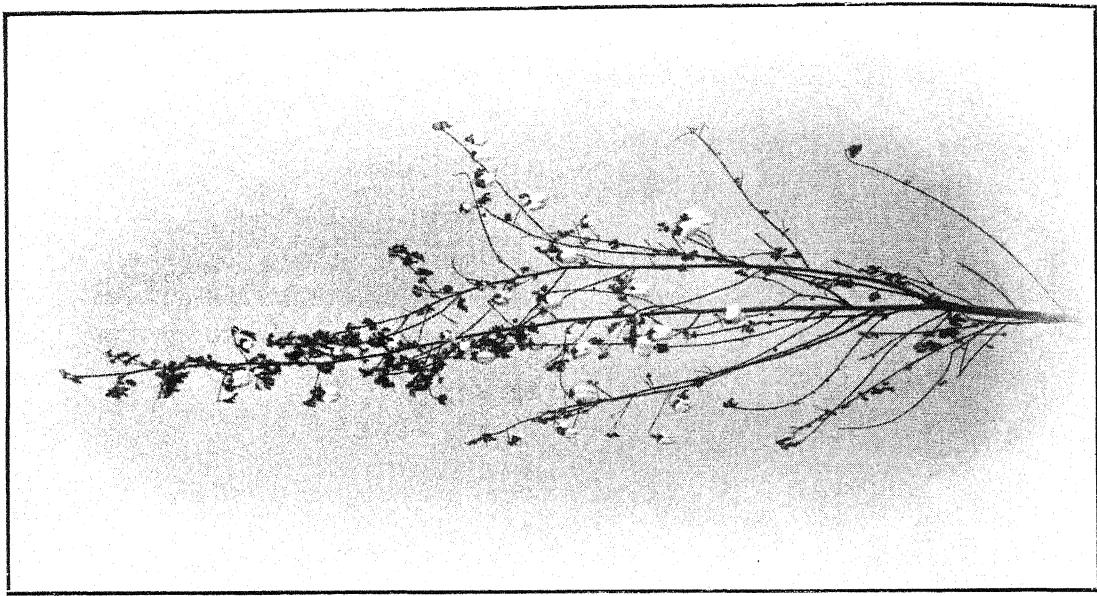


Fig. 1. A PLANT FROM CROSS-BRED RACE (1).

Fig. 2. A PLANT FROM CROSS-BRED RACE (2).

These two photographs are taken at the same distance from the plant and illustrate the "leggy" habit of the latter.



For ginning percent several sources are available. Among the *desi* types there are pure races giving a ginning percent up to 43 and 44. These are, however, invariably coarse and short in the lint. There is also the Garo Hill cotton with a high ginning percent, above 44.

The size of boll varies much in the different races of *desi* cotton, being comparatively large in some cottons received from Dholpur. The plant *par excellence*, however, as regards this character, is the Garo Hill cotton.

Length of fibre may be derived from two sources, the *nurma* or the *bani* cotton. Of these the former plant has been chiefly used owing to its greater robustness.

To obtain a really fine silky lint the use of the *bani* cotton is essential as it is the only cotton possessing this character in full development—the best samples of this cotton being as fine as American, both having an area of transverse section of 1,000 fibres of 0·13 sq. mm.

If the argument has been followed, it will be seen that the ideal plant can only be built up by combining the best characters of three or even more races. In attempting this, numerous other subsidiary characters have to be taken into consideration, so that the problem is far from simple. It will now be shown how far progress has been made in the effort to reach the ideal plant, and a description will be given of a few of the more important cultures which have been obtained in a pure state and show to a greater or less degree an advance in the direction of the ideal plant.

(1) From a cross between K 7 and *nurma*. The stem is more erect than that of K 7 and therefore the plant has an improved habit. This plant is very fertile. There still remains a certain amount of variability in length of staple and ginning percent which must be eliminated before samples will be available for test in the mills, but the higher grades are far in advance of any now cultivated in the United Provinces and, in some instances, a ginning percent of 37 is attained.

(2) From a cross between a coarse, but high, ginning *desi* and *nurma*. The plant is moderately early flowering but 'leggy';

in other words, the vigour passes into the lower vegetative branches, the upper fruiting branches remaining slightly developed. Owing to this habit the plant can never yield a remunerative crop owing to the small amount of fruit. The lint, however, is long and of medium fineness and is the best of those so far produced in sufficient bulk for a practical test in the mills. The ginning percent is 30—33. The following report, by Messrs. Briscoe & Vernon¹ of the Elgin Mills Company, Cawnpore, refers to this culture.

Report on the working of the K 26 type cotton.

Nett weight of cotton, 167 lbs.

Waste made in Blow room, 4·7 per cent.

Comparative Wrappings of K 26
and American cotton we are now using, being 20 points on to Middling.

Twist Yarn from Rings.

K. 26

Wrappings.
24-39 counts

Test.
53 lbs.

AMERICAN.

Wrappings.
23-26

Test.
53 lbs.

37-03 counts

Weft Yarn on Mules.

26 lbs.

37-00 counts.

30 lbs.

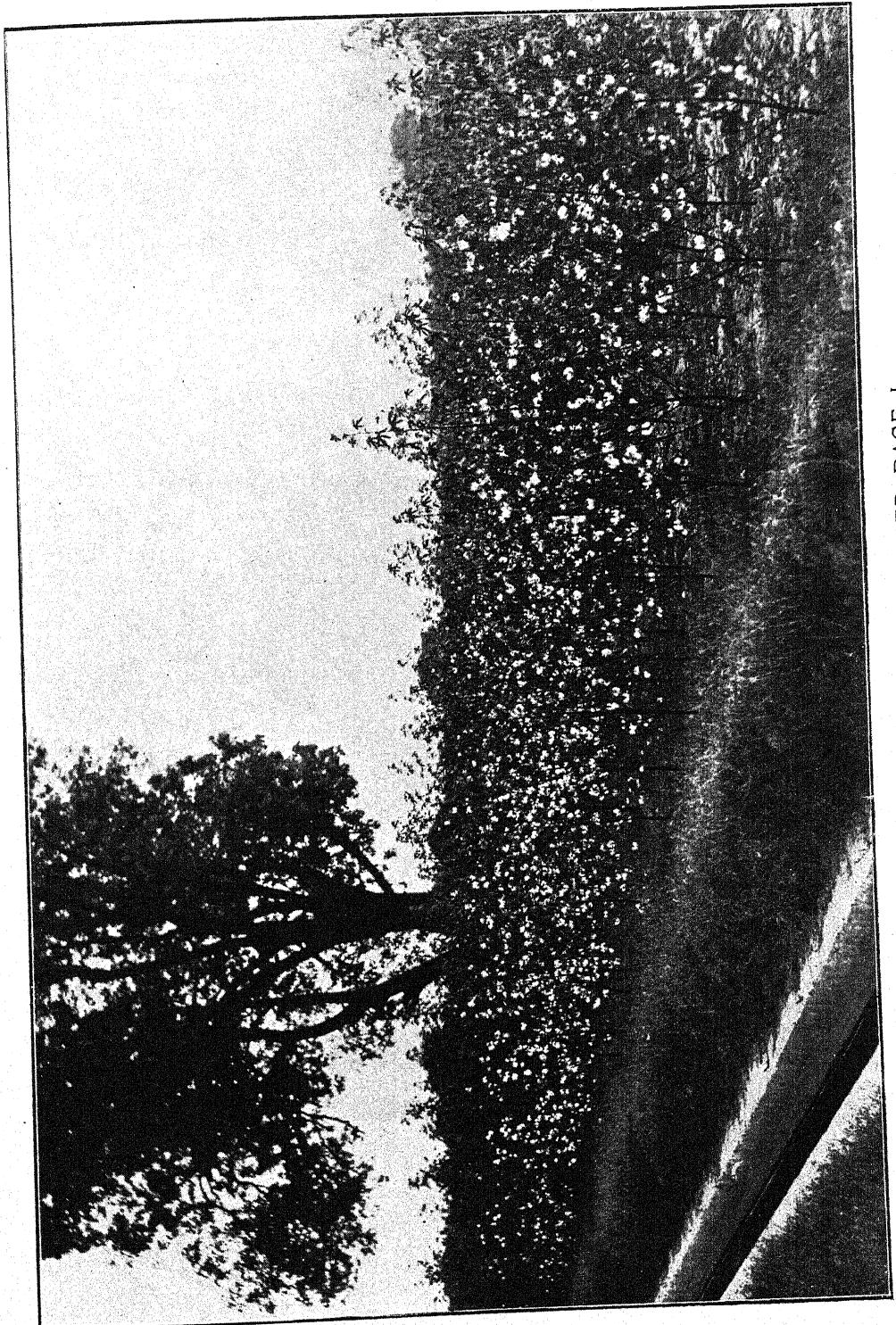
General Remarks.

Note.—These wrappings and tests were taken about 10 A.M. on the 14th May 1914 which was a comparatively hot and dry day and, therefore, not conducive to getting a good test. I consider that if the tests had been taken in February we should have had at least 10 per cent. higher results especially as regards the fine weft yarns. The machines which the cotton passed through were exactly as in former tests, being all new and in very good order. In the warp yarn we should have run it with at least 5 per cent. less twist which means of course increased production and a better yarn. I judged the cotton from a spinner's point of view on the following :—

1st.—Length and uniformity of fibre.

¹ The writer takes this opportunity of expressing his great indebtedness to these gentlemen for the tests they have carried out and the reports they have supplied on these new cottons.

PLATE V.



A FIELD CROP OF CROSS-BRED RACE I.



2nd.—Fineness of fibre.

3rd.—Natural twist.

4th.—Strength and elasticity.

5th.—Colour.

6th.—Freedom from impurities (broken seed, leaf, nep).

1st.—The length was $1/8$ " over our American. Uniformity excellent, in fact we have never come across a better cotton in India.

2nd.—This is coarser than American and even Purbhani or Barsi which we use as warp cottons, this feature shows against it in the 36's weft, because the finer the counts, the less the number of fibres in the cross section of the thread.

3rd & 4th.—These it possesses in a marked degree 10 to 12 per cent. over our American. These are points which stamp it as an extra good warp cotton up to 24's.

5th.—Colour. An extra pure white cotton which shows up well against American and fits it especially for cloths which need bleaching or dyeing.

6th.—The refraction shows that these are almost *nil*. Freedom from nep was a special feature. Natural and artificial nep are always what we expect to find in all Indian cottons. It is a most serious fault because even the cards do not take it all out. It carries forward and shows in the finished thread as a thick soft place, always a weak spot. Neppy yarn is of course absolutely unfit for warp and as weft it shows up on surface of cloth and even in after processes of dyeing is the cause of the cloth not taking up the dye equally.

The above are the chief points in good cotton which render it fitted for the production of a commercial thread and with exception of No. 2, K 26 possesses them all.

(Sd.) W. VERNON.

(3) This culture is very similar to the latter but is derived from a cross between *nurma* and *bani*. Owing to its habit and low ginning percent (26-30) it can never produce a remunerative field crop and owing to the exigencies of space, it has never been grown in sufficient quantity to yield a practical test. It possesses, however, the silkiness of the *bani* cotton and is, without question, the finest cotton so far produced.

The above three races have all red foliage and a red, or pink, flower.

(4) From a cross between *nurma* and a white flowered *desi* a series of forms are now being grown which are not to be distinguished from the ordinary *desi* plant until the fruit opens when the quality of the lint shows their superiority. These are now under comparative trial at Aligarh and at other farms in the cotton tracts.

(5) From a cross between a *desi* cotton and the Garo Hill cotton. This is a fertile plant with large bolls and a ginning percent which touches 47. The lint, however, is coarse.

The above descriptions briefly outline the races of cottons which have been established in a state of purity. It will be at once recognized that in no case do they fit in fully with our preconceived notion of the ideal plant. Another feature of these races is that they are in each case the direct result of a single cross and, from what has been said above, it was not to be expected that the ideal plant would be thus directly obtainable. We are here faced with the time factor; the selection and the extraction in pure form of desirable races from the progeny of such divergent plants as the above is a matter of several generations and, though the work of re-crossing among these purified forms is now well advanced and in some cases has reached the third generation, a further period will be required before pure races containing more than two original types in their parentage will be available for extended sowing. This may, perhaps, be illustrated by a single instance. There is now the third generation of a cross between races 1 and 3 as described above. These plants contain in their parentage the *nurma*, *bani* and Type 7 cottons, and it is confidently hoped to select from these

a plant bearing a considerable degree of approximation to the ideal plant. This instance, further, will emphasize the necessity of "knowing what we have to do." Race 3 in itself is of no economic value and would, on this consideration alone, be at once discarded. It possesses, however, the combination of fine lint on a robust plant such as is found nowhere else. Its value as a means to an end is, consequently, considerable.

So far in this article attention has been confined to those points which have direct bearing on the quality and quantity of lint produced. Subsidiary points also require brief consideration. The writer has elsewhere referred to the advantage of a characteristic colour in the foliage of any new form by means of which the detection of mixtures and crosses would be much simplified. It is partly for this reason that the *nurma* plant has so largely entered into the crosses made. The lint, however, is not the only produce of the cotton plant which is of value. The seed has a value both as a source of oil and as a cattle food. It has so far been impossible to consider the question of oil content—breeding for such characters is, as yet, in its infancy, and the problem is sufficiently complex without taking into consideration additional factors. As a cattle food, however,—whether directly or indirectly in the form of cake,—the value of the Indian cotton seed is largely depreciated by the coarse fuzz remaining on the outside of the seed after the lint has been removed. Such a fuzz, though present in all the Indian forms of cotton, is not invariably present, and naked seeded forms, both of Egyptian and American cottons, are well known. These forms will not hybridize with the Indian races. Recently, however, among certain cottons received from China, some plants have been found which are naked seeded and completely fertile when crossed with *desi* forms. These all lack the necessary robustness of habit; but by crossing these with the Indian cottons, robust races have already been raised with a naked seed, and their production appears to present no difficulty.

Before concluding, the question of the evidence that exists as to the limits within which improvement is possible may be briefly touched upon. Reference has already been made to the common idea that long staple cotton cannot be combined with an early

maturing habit of plant. It has been shown above that plant habit is not synonymous with early maturity, but is a combination of two characters at least—the type of branching and the vigour of the fruiting branches.

In the second and third races of extracted forms described above, the long staple of the *nurma* plant is found combined with a branching habit which only lacks the character of vigorous growth of the reproductive branches. We have, therefore, in this group obtained the long stapled, early maturing, plant which only lacks one character to make its extended cultivation remunerative.

There seems, thus, no evidence to justify the belief in the mutual repulsion of long staple and early maturing habit. When, however, the two characters, high ginning percent and fineness of fibre, are considered, there do appear to be valid reasons for considering the two characters to be, to a certain extent, mutually exclusive.

For our purpose the problem may be given in its simplest form. It has been stated above that the ginning percent is dependent in part on the weight of 1,000 fibres; in other words, the highest ginning percent is only obtainable when the weight of 1,000 fibres is a maximum. The weight of a fibre (and hence of 1,000 fibres) is proportional to its volume, which is given by the product of length by the area of cross section. The range of the latter, as we have already seen, is given by the numbers 50 and 12. For a fibre whose cross section is represented by 12 to weigh as much as a fibre with a cross section represented by 50, it is necessary that the length of the former should be over four times that of the latter. In considering the subject of length, it was noted that the limits found in Indian cottons were 12 mm. to just over 30 mm. Hence it will never be possible to make good the loss of weight due to fineness by increase in length. Fine cottons can have only a moderate fibre weight and consequently only a moderate ginning percent. What the limiting figure is it is as yet not possible to say. That it is well above the 25-26 percent of the *bani* cotton is not doubtful; that it is as high as 36 percent seems possible; but that it can be as high as 46-47—the highest figures of which the writer has personal record—is not to be supposed.

THE CONTROL OF *KOLEROGA* OF THE ARECA
PALM, A DISEASE CAUSED BY *PHYTOPH-*
THORA OMNIVORA VAR. *ARECÆ*.*

BY

L. C. COLEMAN, M.A., PH.D.,

Director of Agriculture, Mysore.

ALTHOUGH the mycological workers in India are very few, a considerable number of plant diseases have already been investigated more or less thoroughly. If we turn, however, to the practical application of the knowledge thus gained, we must confess that only in comparatively few instances has the control of plant diseases been carried out methodically and successfully, and still more rarely has it been taken up to any considerable extent by the agriculturists themselves. An account of the work which is being done in Mysore in connection with the disease known as *koleroga* of the areca palm may, therefore, not be entirely without interest.

To understand the nature of the work a short description of the conditions under which it is being carried out seems necessary. The disease is confined to a region in the western part of the State, having an annual rainfall varying roughly from seventy-five to three hundred inches. It comprises a strip about one hundred miles long and from twenty to thirty miles broad along the extreme western edge of the Mysore plateau. This strip is connected on the north and west with an area in North Canara and on the west with one in South Canara, in both of which the disease is prevalent. It is also to be

* A paper read at the Indian Science Congress held at Madras in January, 1915.

found in South Malabar and Cochin and, as far as it has been possible to ascertain, these are the only regions in India or, for the matter of that, in the world where it occurs.

In the infected region practically the only important crops grown are paddy and areca nut. The paddy occupies the low-lying lands along streams and the lower stretches of innumerable valleys. The slightly higher ground above the paddy lands both in the troughs and on the sides of the valleys is given over to areca nut gardens. These gardens frequently extend for miles in one practically continuous range forming one of the most charming features of the picturesque Mysore *malnad* and furnishing at the same time one of the chief sources of its wealth.

The gardens are for the most part owned and actually cultivated by Havik Brahmins who, although they cannot be said, as a class, to be highly educated, are, with scarcely an exception, literate. They thus form a body of men who can be reached to a considerable extent through the printed page and who are somewhat readier to take up the new and discard the old than are the majority of Indian agriculturists.

Another important feature in the situation is the value of the crop itself and the great havoc that has been done by the disease. A well cultivated areca garden will, in good years, give returns as high as Rs. 500 or 600 per acre, though the average is, of course, much lower than this, and where the disease is virulent the returns may be reduced to practically nothing at all.

It will thus be seen that there are at least some conditions favourable to the introduction of improved methods of controlling the disease, provided these can be made economically practicable. There are at the same time many, what at first appeared almost insurmountable, difficulties. In the first place, the almost incessant rains of the monsoon reaching, in some places, as high as 20 inches in one day make work at that season a matter of the greatest difficulty. Most of the gardens are situated at considerable distances from the main roads and are practically cut off for days and even weeks from the outer world during the season when the disease

is virulent. Lastly, the disease, attacking as it does the bunches of nuts situated at the top of slender trees from 60 to 80 feet high, is one that presents many physical difficulties in the way of its control. In fact it seems highly probable that in no other part of the world has the scientific control of a disease been attempted where the initial difficulties have been so great.

With regard to the method of control introduced, it is that of spraying the bunches with Bordeaux mixture before the disease appears. Considering the abnormally heavy rainfall concentrated in a few months (in some of the areas treated 140 inches of rain have fallen during the one month of July), it was concluded that it would be practically useless to attempt spraying with the Bordeaux mixture as ordinarily applied and a solution of double strength was used. To this was added an adhesive mixture consisting of ordinary colophonium resin dissolved by heating with soda in water. The finished mixture showed adhesive powers which, considering the torrential rains it had to withstand, were remarkable. In most cases one treatment at the beginning of or early in the monsoon has been found sufficient to protect the nuts from the disease till danger of its appearance and spread is over.

The next difficulty to be surmounted was the application of the spray mixture to the bunches. In the first experiments a large barrel sprayer was used. This was mounted on two wheels and to the pump was attached a line of hose sufficiently long to extend to the tops of the trees. The sprayer itself was run along between the rows of trees and a trained climber then ascended with the hose and directed the spray mixture which was pumped up from below. The spraying could be done fairly satisfactorily, but the difficulty of moving the sprayer about in gardens with deep drainage ditches at frequent intervals was very great. Added to this was the difficulty experienced by the climber in holding seventy or eighty feet of hose full of liquid at the top of a very slender tree during the heavy winds of the monsoon. The danger of a serious accident was great and had it occurred during the initial stages of the work it would almost certainly have damned the whole method of treatment in the eyes of the extremely sceptical garden owners.

It was thus found necessary to discard the barrel sprayer and, as ordinary knapsack sprayers, requiring as they do the use of both hands for their manipulation, were quite out of the question, a special type of sprayer had to be procured. A small air pressure sprayer was therefore specially imported for this work. This sprayer, which has been found admirably adapted to the work, holds rather less than one gallon of liquid, a quantity sufficient to spray from eight to fifteen trees. It is very strongly made and free from complicated parts. Sprayers imported six years ago and given very rough usage since are still working satisfactorily. There is, in fact, only one serious drawback to the sprayers and that lies in the fact that they are or were made in Germany. Luckily a large English firm has, within the past two or three months, agreed to take up the manufacture of sprayers similar in every way and at practically the same cost, so that a supply is assured.

The spraying work during the first two years was carried out entirely at the expense of Government. Subsequent to that time sprayers have been lent free of charge to those desiring to have small parts of their garden sprayed as a demonstration measure, but the garden owners have had to bear the expense of material and labour. In connection with this demonstration work another difficulty was experienced. The small permanent staff of the mycological section was quite incapable of dealing with the work on a large scale. It was therefore decided to utilize local men as temporary fieldmen. Where possible these men were obtained from among the families of garden owners themselves and only those were selected who had a good knowledge of local conditions and could read and write the vernacular. These men were first given a course of training in the use of the sprayers and the preparation of the mixture, and were then distributed throughout the affected area, their work being supervised by the permanent staff. This utilization of local men for the work has proved an unqualified success and has allowed a large area to be covered at comparatively small expense. The fieldmen are engaged for the monsoon season only so that the expenses on that score are reduced to a minimum.

After three years of preliminary experimental work, during which the garden owners had ample opportunity of judging at first hand with regard to the efficacy of spraying, it was decided to offer sprayers for sale. Orders were issued to the men engaged in the work not to do any special canvassing as the intention was to ascertain just what effect the demonstrations themselves had had. The results may be said to have been decidedly gratifying as is shown by the following record of sales :—

| | | | |
|------|----|----|-----|
| 1912 | .. | .. | 31 |
| 1913 | .. | .. | 36 |
| 1914 | .. | .. | 110 |

Still another difficulty had to be met, *viz.*, the procuring of the spray materials. While all the ingredients are locally obtainable the stocks in any one place are small and the prices correspondingly high. The Department had, therefore, to arrange for procuring the various ingredients in large quantities and stocking them in various convenient distribution centres. The work has expanded so rapidly that during the past year over six and a half tons of material were purchased and stocked in these central depôts to supply the demand.

As over one hundred garden owners are now carrying out spraying quite independently of any assistance from the Department, it is impossible to give accurate figures of the total area sprayed, but from the sales of sprayers and spraying materials not far short of six hundred acres must have been sprayed during the past year against less than two hundred acres during the previous year and about one-half an acre six years ago. From this there can be no doubt that large numbers of the garden owners have been convinced of the practical advantages of the treatment. Estimates of the actual saving which is now being effected by the treatment can, of course, be approximate only, but one leading garden owner, and the first man to take up the work on a large scale, has estimated that the spraying of his garden of twelve acres has, during three years, saved him Rs. 4,000. This is at the rate of more than Rs. 100 per acre per year. From this and from other

information it seems certain that the savings during the past year must have approximated Rs. 50,000. It is anticipated that under average conditions of virulence of the disease the saving will rise to about a lakh of rupees in the present year.

But the work has not been confined to demonstration. Experiments on the preparation of the most economical and efficient spray material and more especially the testing of a large number of adhesives have been carried out in a special experimental garden. This garden hitherto leased by Government has now been acquired and becomes a permanent experimental garden where work on the cultivation of the areca nut and the testing of areca nut varieties will be associated with that more especially related to combating the disease.

A large number of adhesives have been tested in this garden. Of these the resin soda mixture has proved decidedly the most satisfactory and has therefore remained the one generally recommended. One of the interesting features of these experiments on adhesives has been a study of their action upon the physical composition of Bordeaux mixture. As is well known Bordeaux mixture is prepared by mixing a solution of copper sulphate of definite strength with a suspension of lime in water. The result of the reaction is the formation of a pale blue precipitate which settles very slowly and it is by the slow solution of this precipitate on the leaves that the fungicidal action of the mixture is produced. The chemical composition of the precipitate apparently varies considerably with different methods of preparation, but as this has formed the subject of special investigation by Pickering and many others, it is unnecessary to touch upon it here.

Undoubtedly, however, the efficacy of the mixture, especially with regard to its adhesive power, depends to a great extent upon the physical composition of the precipitate. The finer and lighter it is the more perfect will be its suspension in the liquid, the evener will be its distribution on the leaves and the greater will be its power of adhesion. This is recognized in all practical directions for the preparation of the mixture which are invariably insistent upon the necessity of either adding the lime to the copper sulphate under constant stirring or of pouring the two simultaneously into

a third vessel. Experiments readily show that with these methods of preparation the precipitate settles much less rapidly than where the copper sulphate is added to the lime.

If we now turn to the mixture as used against the *koleroga* fungus—where what is practically a resin soap is added to give it greater adhesive powers—we find quite a different state of affairs. If the experiment is repeated we find that the mixture prepared by adding copper sulphate to lime settles much more slowly than when lime is added to copper sulphate. The reason for this difference is at present being investigated. It is cited here as an interesting fact which, speaking personally, has not previously been observed, as well as to show the necessity for the utmost care in experimental work with Bordeaux mixture where other ingredients are added.

There remains for discussion only one other phase of the work. So far a description has been given only of the work in connection with keeping the disease under control. This has been effectively done, but the necessity for annual treatment remains, for it is capable of spreading so rapidly that one or two isolated trees bearing infection are capable of infecting a whole garden. The complete stamping out of the disease throughout the whole infested area would be a herculean task which could be accomplished, if at all, only with the fullest co-operation of all the garden owners. However, there are, here and there, in the midst of badly infested tracts, isolated gardens which have remained free from disease and there are also extensive, more or less isolated areas where apparently all the conditions are favourable to the development of the disease but in which it has not yet made its appearance. There is therefore considerable hope that the disease can be stamped out from isolated tracts provided the whole area in the tract is thoroughly treated. That is, if an area well isolated with little or no danger of infection from other gardens is so thoroughly treated that during the whole season not a single nut is attacked, we might expect to find the disease stamped out. However, a study of the fungus shows us that this is by no means certain.

To those not conversant with mycology it may be stated that the fungus causing the disease produces two kinds of reproductive

bodies or spores. The first of these are formed in special egg-shaped organs called sporangia on the surface of the nuts. Under certain favourable conditions these sporangia burst open at the apex liberating large numbers of motile spores which are responsible for the spread of the disease during the monsoon. These spores are carried by the driving spray from one tree to another and thus bring about fresh infections.

These zoospores, however, are unable to withstand the slightest degree of drought and so are entirely unsuited to carrying the fungus over through the dry season. For this purpose resting spores (oospores) are formed which arise as a result of the sexual union of male and female elements. We have not yet been able to ascertain under just what conditions these resting spores germinate, but work done by Hartig on a closely related form in Europe has shown that the oospores may remain dormant for over two years. We thus see that even should the disease be kept in complete check throughout one or even two years, there is danger of some of these oospores still having retained their powers of germination and so being able to cause a fresh outbreak of the disease. In order to be able to stamp out the disease it would, therefore, probably be necessary to keep it from developing in a garden for at least three years and a longer period might even be required.

Experiments with the object of entirely stamping out the disease are now in progress, and in one garden, situated in an area with an annual rainfall of three hundred inches, we have succeeded in preventing the disease from appearing at all for the past three years. During the present year this garden will be left free from treatment and, as it is well isolated, there are strong hopes that the disease will be found to have permanently disappeared. Other experiments of a similar nature have been begun and a total of twenty-two acres of garden are now being treated with this object in view. Should the experiments prove successful an endeavour will be made gradually to extend the area of stamping out operations, but this will be possible on a large scale only if we can obtain the fullest co-operation of the people directly interested. Whether this can be obtained remains a question for the future to solve.

RECENT HISTORY OF THE COTTON IMPROVEMENT WORK IN TINNEVELLY AND RAMNAD DISTRICTS.

BY

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THE history of the recent efforts to improve the cotton crop in the area where "Tinnevelly" cotton is grown, commenced in 1905, and the procedure adopted was that suggested in the Government of India's letter No. 23-9-36 of 16th September 1904.

Letters were addressed to the principal firms interested in the cotton trade in this tract, who were asked to assist the Department by furnishing the names of farmers or villages, who were noted for the quality of their produce. In response to this request the names of many persons and villages were supplied, and officers of this Department were deputed to visit these places, to examine the crops grown and to interview the growers. Many of the persons whose names were given, turned out to be dealers in cotton and not actual growers. However these tours were of considerable value in determining the variety of cotton most favoured in different parts of the tract ; and, in general, it was found that in the north of the tract the variety *upparam* (*Gossypium herbaceum*) predominated, while in the south the variety *karunganni* (*Gossypium sp.*) was held most in esteem. Counts were made in the field in all villages visited. In the north from 65 to 90 per cent. of the plants in the field were *upparam* and the rest except for a few having intermediate characters, were *karunganni*. The proportion of this mixture in general changed, until in the south of the tract the proportions were reversed

and 65—90 per cent. of the plants were *karunganni*, while the rest were *uppam*. Only in two or three villages were any pure crops found. These were in the *karunganni* tract in the extreme south.

All through the tract, however, it was noticed that there was no uniformity in the proportion in which these varieties were mixed. One field might contain only 10 per cent. mixture while the adjoining field might contain 30—40 per cent. or even more mixture. The best villages were those which still preferred to hand-gin their *kapas* and only to sell their lint, while the worst were those which sold all their *kapas* and depended on outside dealers for their seed.

It was fairly obvious, however, that there were genuine reasons, among the more intelligent class of *raiyats*, for this variation through the tract in the proportion in which these varieties were mixed. The *uppam*, though later in showing signs of maturity, is an even ripening cotton and the bulk of the crop can be harvested within two months. Thus in the north where the sowing rains are early and where it is possible for the crop to ripen its *kapas* before the hot weather sets in, the *uppam* was preferred to the *karunganni* which, though it commences to ripen sooner, does not ripen evenly. This means that the picking would continue for three or four months and the probabilities are that many of the immature bolls would shed when the hot weather sets in. In the south it is seldom that the crop is sown before the end of October or beginning of November. This means that the harvest is from six weeks to two months later than in the north and that the hot weather may in any season set in before picking commences. The *karunganni* which never has many bolls ripening at the same time would naturally withstand the effects of the hot weather better than the *uppam*, which might be full of young bolls when caught by the hot weather. In the middle of the tract a mixture of about half and half of the two varieties was generally preferred, as it is not possible to foresee which variety the season would suit best. Even in the *uppam* tract a small proportion of *karunganni* was liked, as the more silky quality of the cotton improved generally the appearance of the sample of lint, while in most places in the south a small quantity of *uppam* was generally preferred as it improved the colour of the lint.

The general opinion of spinners who were consulted however was that it was of much more importance in the first place to improve the staple and to leave the question of colour alone and the simplest method of doing this was to obtain uniformity regardless, for the time being, of quality. Hence the first attempts to improve the cotton of this tract were directed at improving the seed supply. Arrangements were made both in the *uppam* and *karunganni* tracts to procure *kapas* as free from mixture as possible. In the north arrangements were made through Messrs. A. & F. Harvey & Co. to purchase *kapas*, obtained from the mid-season pickings of specially chosen crops, at a slightly enhanced rate. The lint was purchased by the firm and the seed by the Department, who also bore extra charges occasioned by the enhanced rate of purchase and by the fact that all *kapas* was hand-ginned. In the south it was possible to make arrangements with private farmers to supply the Department with hand-ginned *karunganni* seed obtained from their own crops. In this way about 76,650 lbs. of fairly pure *uppam* seed and about 29,000 lbs. of *karunganni* seed were obtained. Of this, however, only 22,860 lbs. of *uppam*, sufficient to sow about 2,286 acres and 14,100 lbs. of *karunganni*, sufficient to sow 1,410 acres, were sold as seed. In this distribution attempts were made to enlist the assistance of the District Revenue authorities. The availability of the seeds was notified in the District Gazette and in the village sheets. Forms of application for seed were at the same time distributed to village officers. Applications for seed had to be made through the village headman either to the taluk headquarters or to the Koilpatti Agricultural Station. The distribution through the Revenue Department signally failed, nor was any record forthcoming at the time when the crops should be inspected as to how the seed was disposed of. Much of it, it afterwards turned out, was distributed to important villagers who could not well refuse to buy, but it was not used for seed and was fed to cattle. The value of the seed thus disposed of was not all finally recovered until July 1908.

Most of the seed which was sold for sowing purposes was supplied from the Koilpatti Agricultural Station, *karunganni* seed being mainly sold in the south and *uppam* in the north. In

spite of the poor sales, what seed was sown gave great satisfaction and was instrumental in forming a large tract of pure *karunganni* in the Ettiyapuram Zemindary.

Mr. C. Benson, who at that time was Deputy Director of Agriculture for the whole of the Madras Presidency and who had orders to carry out similar work in all other cotton-growing tracts of the Presidency, in his report on the results of the work here and elsewhere stated that too much had been attempted.

In the following season somewhat similar arrangements were again made to collect *uppam* seed with the funds still available in the 1905-06 financial year; but by the time orders were received on the proposals it was too late to make similar arrangements for the purchase of *karunganni* seed, which in any case could not have been made within the financial year 1905-06.

While this work had been going on, a considerable amount of useful information was being collected on the Koilpatti Agricultural Station. This agricultural station is situated in the centre of the cotton area, i.e., midway between the *uppam* and *karunganni* tract. Here these two varieties had been grown separately and opinions obtained on the quality of the lint. These were unanimously in favour of the *karunganni* as being longer, finer and stronger than the *uppam*. Many other indigenous varieties collected from other provinces in India had been tested and compared with the Tinnevelly and other Madras varieties. Several exotic cottons of the American Upland type were also tested. These included Cambodia and several of the improved "long-stapled" American Upland varieties. On the conclusions drawn from these trials, Benson was in a position to make very sound recommendations on the expenditure of the funds placed at the disposal of the Government of India by the British Cotton Growing Association. These insisted on the improvement of existing local varieties and the encouragement of such local varieties which were found to be superior in quality and equal if not superior in yield; and to this end an allotment of the British Cotton Growing Association's funds of Rs. 3,000 was made for the purpose of raising seed on a substantial scale of the *karunganni* variety of cotton.

As this sanction was not communicated until the end of September, it was not possible to do anything for the season then about to commence, but fortunately the rains were early and it was possible to arrange for the purchase of pure *karunganni kapas* in the south before the close of the financial year 1906-07.

Of the *uppam* seed collected in 1906 practically all of this appears to have been sold. The bulk of this was sold through the agency of Messrs. A. & F. Harvey & Co. at Virudupatti, who distributed it through their dealers. Only one of these men however kept any record of the persons to whom he sold the seed. The general impression, both here and around Koilpatti, where seed was distributed, was that this was very much superior to "bazaar" seed. It germinated better and more quickly and gave a stronger and more drought-resistant crop. In all about 14,800 lbs. were sold, sufficient to sow some 1,480 acres. It was satisfactory to note also that as a result of the previous year's seed distribution in the Ettiyapuram Zemindary, a tract of pure *karunganni* estimated at over 2,000 acres had been established and that the Zemindary authorities had stored *kapas* for seed which would give sufficient seed to sow nearly 3,000 acres in the following season.

In 1907-08 considerable development commenced in the work of cotton improvement. In the first place, it was found impossible with the staff at the disposal of the Department to attempt to cope with the whole of the tract. Secondly, it was found impossible to try and push two types of cotton. Both the *uppam* and *karunganni* were found to yield on the average practically the same; but the yield obtained varied considerably from year to year, the season sometimes favouring the one and sometimes the other. If in one season *uppam* had yielded better than *karunganni*, then the next year the *raiayats* all favoured *uppam* which would in the following season probably not fare as well as the *karunganni*. Thus, with the impetus given to *karunganni* by the decision to push this variety with the funds placed at the disposal of the Department by the British Cotton Growing Association, it was decided to confine, for the present, the work to the southern half of the tract. In this year about 12,400 lbs. of *karunganni* seed

were collected and sold, there being an eager demand for the same.

Meanwhile on the Koilpatti Agricultural Station considerable knowledge of the cottons of the tract was being obtained, while improvements in the method of cultivation were being tried and, where successful, were adopted. Benson in 1905-06 strongly suspected natural cross-fertilization to be common and selected many plants growing in mixed crops of *karunganni* and *uppam* which he classed as "putative crosses." At the same time he made crosses between *karunganni* and *uppam*, *uppam* and *karunganni* and also obtained fertilized seed of both these varieties by crossing with pollen from other selected plants of their respective varieties. From the former were obtained plants which closely resembled their respective female parents in the first generation except for much greater vigour. These in the second generation split up into all manner of types, many of which were similar to the "putative crosses" marked by Benson. The latter also showed much greater vigour, but in the second generation the two varieties behaved quite differently. The *uppam* showed practically no variation. The plants retained their greater vigour, but practically no variation could be found in the lint or seed or in the habit of the plant. It seems, therefore, evident that the *uppam* is a distinct species. In the case of *karunganni*, however, in the second generation, very considerable differences were noticed in the progeny, both in the habit and in the character of the seed and lint. Hence it is probable that the *karunganni* is not a separate species but merely a cultivated variety. This is further borne out by the fact that Fyson, who examined the crop of the second generation of the crosses between *uppam* and *karunganni*, could not find any characters which followed Mendelian laws.

Several plants of *uppam* \times *uppam* and *karunganni* \times *karunganni* were selected and grown as unit strains. It was found that the majority of the *karunganni* selections remained true to type both as regards the shape of the plant, the habit, the ripening, the fineness or otherwise of the lint and the percentage of lint to seed. Thus there were possibilities even then of producing strains which in time would prove superior to the ordinary *karunganni* and strains

which would suit not only the seasonal conditions of the south but also those of the *uppam* tract in the north. The selection of *uppam* was subsequently discontinued as it was found impossible to prevent crossing of the two varieties.

In the meantime it was imperative to maintain and if possible improve the ordinary *karunganni* so as to popularize as much as possible the seed which the Department was selling. The *karunganni* crop grown on the Koilpatti Agricultural Station already showed its superiority over that being then distributed by the Department. This improvement had been effected by plant to plant selection, the selection being done entirely by the habit of the plant. In this way a bulk selection was each year made, the crop from which provided sufficient seed to sow the whole area available on the Agricultural Station. Thus in 1908 it was decided to start seed farms in the district where not only the *karunganni* seed, obtained from the crops grown on the Koilpatti Agricultural Station, could be grown but where the system of drill cultivation found so successful on the Agricultural Station could be demonstrated.

An account of this latter work has already been contributed to this journal (Volume IV, page 188), and it is enough to say that the results obtained were eminently successful; so much so that, whereas in the first year persons who raised seed farms for the Department required much persuasion to agree to do so, in the next year it was possible to pick and choose and thus to select better land. Herein however both the *raiylats* and the Department were too greedy. *Raiylats* who had seen the seed farm crops the previous year, and in most cases no such yield had ever been obtained on those particular lands before, came forward and offered their very best lands as seed farms. These are lands known as "Cumbadi" (Lit., beaten by *cumbu*), i.e., lands which are very heavily manured and on which *cumbu* (*Pennisetum typhoideum*) is grown every year; this being the principal cereal of this tract. The year which followed started favourably and the crops in the initial stages grew and promised well, but as the plant food was near the surface the crops developed a surface root system which could not withstand dry weather conditions

and the crops were unable to ripen properly. The acre yields were in consequence considerably less than in the previous year.

The seed obtained was similarly sold throughout the south, village depôts being located at suitable places throughout the tract. These were placed in charge of some reliable man in the village who was given a commission on sales effected.

Though the area of seed farms was not materially increased, considerable progress was made during this year and the next in popularizing the use of the seed drill and accompanying implements. There were several difficulties in the way, one of the principal being that it was not easy to sow mixtures with the cotton. Pulses, Coriander, *tenai* (*Setaria italicica*) are usually mixed in small quantities with cotton when this is sown broadcast, and as these are the perquisite of the women of the household, there were naturally objections to sowing cotton pure. However as greater experience has been obtained in drilling, this objection has largely been overcome, nor is there the same objection to pure cotton as there formerly was as this is found to yield better. Moreover bullock hoeing has considerably lightened the woman's share in the cultivation as formerly she had to take her share in the hand hoeing which the crop received ; and in villages where the people are still dependent on the Department for the loan of implements, it is the women who so to speak enter the fray to get first served with the bullock hoes.

The distribution of *karunganni* seed sufficient to sow each year from 10,000 to 12,000 acres naturally had a considerable effect on the quality of the cotton in the south. New ginning factories were put up by cotton buying firms in this tract mainly on account of the superiority of the crop and these combined with two or three seasons of short crop have done much to undo the Department's efforts to keep the crop pure. In 1912 it was found that what a year or two previously had been practically a pure *karunganni* tract was again a hopeless mixture of "bazaar" seed. Although the fact that ginning factories under proper management do much to maintain the quality of export cotton by having the ginning under proper control, their introduction tells very seriously on the quality of the seed sold for sowing. Village dealers instead of ginning the

village *kapas* by hand and selling the lint, now dispose of the *kapas* to travelling dealers who deal directly through the brokers employed by the factory. Consequently all *kapas* whether good or bad is mixed, bad samples are graded up with good, *kapas* which will not pass muster is similarly graded up till it does. The crops in the neighbourhood of these factories further showed that much of the seed had been brought from a distance, and it is probable that this arrived at the ginning factory by cart, being what was refused by the ginning factories further north on the cotton route. *Kapas* instead of being stored dry, as formerly, is now often collected straight from the field and packed immediately into *borahs*. The result is that much of the cotton heats and the vitality of the seed is either weakened or altogether destroyed.

It looked therefore as if all the Department's efforts to grade up the crop to pure *karunganni* were to be of no avail. The seed supply required for the Tinnevelly District (*i.e.*, the south of this cotton tract) may be roughly estimated at 2,500,000 lbs. This means the produce of 8,000 to 10,000 acres. At the present time the Department supplies from 4—5 per cent. of this. It was obviously impossible for the Department to control such a large area of seed farm nor would it be a wise policy to make the *raiyat* entirely dependent on the Agricultural Department for the seed supply. Further the work on the Koilpatti Agricultural Station in producing suitable unit strains of *karunganni* was now sufficiently advanced for rapid development in the district. It was, however, of no use issuing seed if, when the crop was collected, it was to be sold to dealers and lost sight of. It was decided therefore to restrict the area of departmental seed farms to 400 acres and to try and induce villages, which had purchased our seed, to co-operate and take in to the gins sufficient *kapas* to supply, if not the whole, a considerable portion of the village with seed. It was thought that, if co-operation on these lines could be induced, such villages would be useful for putting out, in the first instance, seed raised from unit strains. With this inducement held out to them, three villages in the 1912-13 season agreed to this step. Accounts were kept which showed that this

procedure was sufficiently remunerative to more than pay for the extra trouble involved.

It may be mentioned that the limited supply of seed stocked by the Department and the keen demand for this seed has been largely utilized as a lever to extend the work of cotton improvement. All the seed sold in 1913 was sold on the understanding that the crops would be sown with the drill and in this way drill cultivation has been extended to many new villages. It is true that all who promise this do not act up to it, but very many of them do and last year more than 7,000 acres of cotton and *cumbu* were sown in this way. In the same way this year in arranging village seed depôts, these have in many cases been located in villages on the understanding that the villagers would co-operate for the joint sale of *kapas* in order to get back their own seed from the ginning factories. Last season twenty villages thus co-operated and seed has been stored in them to sow next season about 12,000 acres. To these villages seed of a unit strain will be sold in the coming season in limited quantities, subject to the condition that the villages will again co-operate in a similar way. These limits are fixed according to the estimated seed requirements of the village in the following year. This means that each such village has to all intents and purposes its own seed farm which it is estimated will supply its requirements in full. The strain which is to be issued to them promises to be a great improvement on what is now being grown. Last year it was grown on 12 acres and yielded 620 lbs. of season *kapas* per acre against an average yield of 454 lbs. for ordinary selected *karunganni*. It gave a ginning outturn of 31.3 per cent. against the district average of 25 per cent. and the spinning tests, kindly made by the Tinnevelly Mills, showed that it was quite suitable for spinning 40's. yarn against 26's. yarn for the ordinary selected *karunganni*.

This year a further extension of this work has been started. As already mentioned *uppam* cotton, though considerably inferior to *karunganni* in quality, is the main variety grown in the north of this tract on account of its even ripening habit, and for this reason work in the past has been confined to the middle and south of the tract

where the qualities of *karunganni* are to some extent known and appreciated. The question of the ripening habit of *karunganni* has, however, received considerable attention and several of the unit strains which are being grown have been selected for their evenness in this respect. These are now sufficiently advanced to put out on to seed farms. Two strains are this year to be grown. One which has a ginning outturn of 27-28 per cent., i.e., 2-3 per cent. above the district average for ordinary dry black cotton soil and spins a very good 50's. The other which has a ginning outturn of $33\frac{1}{2}$ per cent. and spins up to 44's. will be grown on a tentative scale in certain villages where much damage is being done to the Tinnevelly cotton by the cultivation of what is known as "Pulichai" or "Mailam" cotton. This is the white flowered *jari* of the United Provinces and it is grown chiefly on lands which can if necessary be irrigated; for the main reason that it has a ginning outturn of 33 per cent. it is encouraged by dealers, who by mixing it with Tinnevelly cotton, can raise their general ginning outturn.

It may be mentioned in conclusion that the Department have throughout this work received every help from Messrs. A. & F. Harvey & Co., both at Tuticorin and Virudupatti especially from Mr. A. Steel, the agent at the latter place. It is through the agency of this firm that the Department have been able to have their spinning tests made, and it is the only firm dealing in cotton in this tract which has so far been prepared to pay the producer an extra price for quality.

COTTON IMPROVEMENT IN BERAR.

BY

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IT is a generally accepted opinion among those who are engaged in introducing improved agriculture in India that there is more scope for improvement in a tract where farming is backward than where it is more advanced. This opinion is not justified by the experience gained in these provinces, and the writer doubts whether it would apply as a rule to India as a whole. The backwardness of the agriculture of a tract is generally due to several factors such as an unfavourable climate, an uncongenial soil or to the want of enterprise among the inhabitants. As a rule, inferior cultivators are found in tracts where the soil or climate or both are bad, because there is less competition there owing to the tendency of the more enlightened to migrate to other parts where the conditions of life are more congenial. It follows, therefore, that as a rule the task of raising the standard of cultivation in a backward tract is an extremely hard one because the soil, the climate and the nature of the inhabitants themselves, all handicap progress. To illustrate what is meant let us compare the *raiayats* of Chhattisgarh in the Central Provinces with those of Berar. In Chhattisgarh the climate is malarious, the outturn of the staple crop, namely, rice, is poor in years of low rainfall owing to the want of facilities for irrigation, and the consequence is that the *raiyat* is poor and unenterprising. Progress in introducing improvements under such conditions must necessarily be very slow. In Berar, on the other hand, the climate is healthy, the staple crop, namely, cotton, is less dependent on the exigencies of the rainfall, the soil is very good, a

failure of the crop is the exception, and the result is that the cultivator is wealthier, more go-ahead and much more advanced in his craft. In a tract of this kind, though the practice of agriculture may have reached a high standard, the conditions are such that still further progress is made easy, for the cultivator is intelligent and readily appreciates the advantages accruing from the adoption of new and better methods of husbandry.

When the Department of Agriculture started operations in Berar about eight years ago by opening an experimental farm near Akola, there were no very obvious lines of improvement which could be seized on. The Berar people cultivated their staple crops, *viz.*, cotton and *juar*, carefully, and had increased in wealth. For all their different varieties of *juar* they had local names and they kept each variety fairly pure; but for their cottons they had only one name *katilvilyati* or *jari* which terms included a mixture of six distinct varieties which, on being grown separately, were found to vary enormously in yield of *kapas* and in the percentage of lint to seed. With a view to making the cultivation of these two staple crops more profitable, elaborate series of experiments were drawn up which have now been carried out over a period of seven years, and which have given results of the very greatest value. However, this article will restrict itself to a brief description of these results in so far as they apply to cotton.

Of the six varieties of cotton forming the mixture known as *jari* or *katilvilyati*, it has been proved conclusively that *roseum*, a white flowered variety giving 40 per cent. of lint to seed, and a large yield of *kapas*, is easily the most profitable cotton to grow under the soil and climatic conditions which obtain in these provinces. The table below shows the average yields obtained from these cottons over a period of seven years:—

| Name of variety. | Average outturn of lint in lbs. per acre, 1907-13. |
|---|---|
| G. N. malvensis | 132 |
| G. N. vera | 146 |
| G. N. roseum | 204 |
| G. N. roseum eutrichicum | 190 |
| Berar Jari (previously grown everywhere in Berar) | 162 |
| Saugor Jari | 156 |
| Bani | 97 |
| Buri | 121 |

It is worthy of note that the yield of *roseum* has been about twice as great as that of *bani*, the variety which was being recommended by the Department previous to the opening of the Akola Farm and the experimental work thereon.

By substituting a selected strain of this *roseum* cotton for *jari*, the farm was able last year to increase its profits on cotton cultivation by Rs. 3,940. It was mainly due to this very material improvement that the farm has made such large net profits every year. The profits last year after paying all expenses including the salaries of the staff amounted to Rs. 5,210.

At an early stage of our experimental work it became obvious that the superiority of this variety of cotton was assured and its improvement by plant-to-plant selection was taken in hand in earnest. Of the many strains raised from single mother plants the highest yielder was found to be one which we have registered as No. 1 *Roseum*. The quantity of seed of this strain distributed to cultivators for sowing gradually increased year by year, till this year it reached the enormous figure of about two million pounds, and we anticipate that in future it will be possible to increase the distribution by nearly one million pounds a year. The production and distribution of this cotton was effected through private seed farms managed by the owners under the supervision of the Department of Agriculture. To these farms selected *roseum* seed was supplied each year from the Akola Experimental Farm. This seed was in turn propagated and distributed in large quantities to cultivators in adjoining villages. But with the rapid increase in the number of seed farms it became evident that concentration was necessary in order to guarantee more efficient supervision. With the assistance of the Registrar of Co-operative Societies some of these seed farms have, therefore, been converted into the central farms of Co-operative Agricultural Seed Unions. Each Union consists of ten or more members, each of whom guarantees to grow only selected *roseum* cotton and to keep all the seed for distribution.

The number of villages included in the Union may vary from one to ten. Each Union has a central seed farm or farms comprising an area of from 25 to 100 acres to which selected seed is supplied every year from the Akola Farm. The areas sown with *roseum* by the other members of the Union have been designated branch seed farms. The main purpose of the central farm is to supply pure seed to the branch farms, but, when more seed is produced on the central farm than is required for the branch farms of the Union, it is sold as part of the Union stock of seed. It is the duty of the Department to see that only pure selected seed is supplied to the central farm and that only pure seed is handed over to the branch farms ; while it is the duty of the Union *kamdar* to see that the seed of the branch farms is kept pure.

For each Union a chairman to preside at their meetings, two supervisors to supervise the field work and a secretary to look after the clerical work of the Union are appointed. Most Unions have appointed a *kamdar* who is a paid worker. He supervises the sowing of all the farms, uproots any alien plants that make their appearance, and looks after the ginning of the *kapas* and the bagging, labelling and distribution of the seed. The only expenditure incurred by most Unions is that of the pay of the *kamdar* which seldom exceeds Rs. 180 per annum. In order to be able to meet such expenditure the members have a Union Fund which they raise among themselves, each paying from 2 to 4 annas per acre of *roseum* cotton grown. The *kapas* of only one Union is ginned on a plant which is the common property of the members. In most cases one of the members has a small ginning plant consisting of two or three gins driven by an oil engine and on this plant he arranges to gin all the *kapas* of the Union at a given rate.

Twenty-two Unions have already been opened of which nine have been registered. The table on the next page gives in a condensed form the profits made by the four Unions which in June last completed a full year's work.

The profits were mainly made on the sale of *roseum* seed. Taking the district as a whole we find that *roseum* seed was sold by Unions

Table showing profits made by the four Unions for year ending 30th June 1914.

| Name of Union. | Number of members. | Area in acres under rosenum cotton. | Quantity of rosenum seed produced in lbs. | Quantity sold in lbs. | Selling Price. | Receipts for seed. | Cost of same quantity of jari seed in bazaar. | Profit on sale of rosenum seed. | Profit on sale of jari seed in bazaar. | Expenditure of Union. | Net profit. |
|----------------|--------------------|-------------------------------------|---|---------------------------------------|------------------------|------------------------|---|---------------------------------|--|------------------------|-------------|
| Gairgon | .. 18 | 609 | 65,694 | 16 to 20 lbs. per rupee. | Rs. 3.218 A. P. 9 0 | Rs. 1,642 A. P. 6 0 | Rs. 1,576 A. P. 3 0 | Rs. A. P. Niz 7 | Rs. A. P. 138 12 0 | Rs. A. P. 1,437 7 0 | |
| Paras | .. 12 | 360 | 40,011 | 40,011 18 lbs. per rupee. | 2,286 A 0 | 1,000 4 0 | 1,286 1 0 | 8 0 0 | 19 10 0 | 1,274 7 0 | |
| Balapur | .. 15 | 268 | 21,600 | 20,360 20 lbs. per rupee. | 1,015 13 0 | 507 14 0 | 507 15 0 | 8 0 0 | 96 0 0 | 419 15 0 | |
| Sonwadhona | .. 56 | 1,441 | 84,160 | 81,360 14 to 16 lbs. per rupee. | 6,069 12 0 | 2,184 0 0 | 3,885 12 0 | 64 0 0 | 310 0 0 | 3,639 12 0 | |

and seed farms at from Rs. 25 to Rs. 46 per *khandi* of 560 lbs. The bazaar rate for ordinary cotton seed was only Rs. 14 per *khandi*. The demand for *roseum* at this price was very great : despite the fact that about two million pounds were produced, more could have been sold had it been available. But the profit from the increased yield of lint, too, must have been considerable, as may be gathered from the summary below, which gives the average yield of *roseum* *kapas* and percentage of lint obtained by the different Unions and seed farms last year, compared with the district average for the year.

| District. | PERCENTAGE OF LINT TO SEED. | | OUTTURN OF ROSEUM COMPARED WITH THE DISTRICT OUTTURN FOR THE YEAR. | |
|---------------|--------------------------------|---------|---|---------|
| | Jari. | Roseum. | Jari. | Roseum. |
| Akola | 35·6 | 39·7 | 300 | 345 |
| Buldana | 34·95 | 39·45 | 301 | 321 |
| Amraoti | 35·57 | 38·75 | 290 | 394 |
| Yeotmal | 34·7 | 39·51 | 247 | 340 |

In addition to these Unions there were 38 cotton seed farms run by private individuals, some of whom will in due time form Unions with the seed farm in each case as the nucleus of the Union.

By starting with seed farms the Department is in a position to select the best material for these Unions ; for it is very important that the individual member should be a good co-operator as well as a good cultivator.

By grouping together the villages in this way to form one agricultural unit improvements can be introduced on a large scale with a minimum amount of effort ; for the Department deals with the Union as a unit, while the Union in turn controls the affairs of the different members of which it is composed. To reduce the work of the Department still further, Union Inspectors are being appointed who are under the administrative control of the central co-operative credit banks—though working under the advice and supervision of the Department of Agriculture. This will ensure still

closer co-operation between our Department and the official and non-official workers in the co-operative credit movement.

Of the other series of experiments carried out on the Farm the rotation experiment with *roseum* cotton as the principal crop has given most useful information. In this experiment cotton grown in rotation with wheat, *juar*, gram and *tur* is compared with cotton grown in the same plot continuously. Before these experiments were started the whole programme was submitted to two of the highest agricultural authorities in India for criticism. They pointed out that the cultivation of cotton on the same land year after year was unsound, as it would tend to intensify the damage done by insect pests and to impoverish the soil. The table below shows the results obtained in practice :—

| Name of crop. | Average net profit per acre from 1907-14. | | |
|-------------------------|---|----|----|
| | Rs. | A. | P. |
| Cotton { | | | |
| Wheat } | 29 | 15 | 0 |
| Cotton and <i>tur</i> { | | | |
| <i>Juar</i> } | 20 | 9 | 0 |
| Cotton } | | | |
| Gram } | 25 | 12 | 0 |
| Cotton } | | | |
| <i>Tur</i> } | 30 | 14 | 0 |
| Cotton .. | 32 | 2 | 0 |

Taking the average value of the outturns per acre over a period of seven years, we find that cotton grown continuously on the same plot proved to be the most profitable system of cropping, and no bad effects from insect pests or soil exhaustion are yet apparent. Continuous cropping with cotton has also been practised in part of the non-experimental area of the Farm with the same good results. Still it is too early yet to recommend it as a general practice to be followed ; for there is in Berar a considerable area of land infested with cotton wilt and there is some reason to believe that its prevalence in certain villages is due to the too frequent cropping of the same fields with cotton.

Another experiment which has given results which are contrary to what was anticipated is that designed to ascertain the advantages

of topping cotton plants when about one foot high in order to stimulate branching. This practice had previously been recommended by the Department to cotton growers though it had never been tested experimentally. The results are given below:—

| | | | | | Average outturn of <i>kapas</i> in lbs. from 1907-13. |
|-------------------|----|----|----|----|---|
| Topped .. | .. | .. | .. | .. | 480 |
| Not topped .. | .. | .. | .. | .. | 523 |
| <i>Duplicate.</i> | | | | | |
| Topped .. | .. | .. | .. | .. | 330 |
| Not topped .. | .. | .. | .. | .. | 373 |

Topping involves considerable expenditure and reduces the yield. It also retards the time of maturing. Needless to say "topping" of cotton plants has been given up on the strength of these results.

The best spacing distance for cotton plants has also received attention. This was all the more necessary as previous to the opening of the Farm the Department had laid it down as an empirical rule that cotton plants should be thinned out so as to stand at a distance of from 12 to 15 inches apart in the rows. The results for seven years are given below:—

| Spacing distance. | | Average outturn of <i>kapas</i> in lbs. per acre from 1907-13. |
|---|--|--|
| Rows 15" apart and plants 7" apart in rows .. | | 520 |
| " 15" " " 15" .. | | 503 |
| " 20" " " 15" .. | | 517 |
| " 20" " " 20" .. | | 396 |
| " 25" " " 20" .. | | 395 |
| Unthinned | | 388 |

In the first five years of the experiment a spacing distance of 15 inches from row to row and 7 inches from plant to plant in the row gave the highest outturn. As the plot increases in fertility, however, owing to the accumulation of the residues of the manure

applied every year, a wider spacing distance has done equally well. The more fertile soil produces larger plants which require more room. The practice followed by some cultivators of allowing all the plants which come up to mature is a bad one, except in the poorest soils. For soil of medium fertility the spacing followed in Plot No. 1, is probably the best : in comparatively rich soil yielding from five to six hundred pounds of *kapas* per acre the spacing distance allowed in Plots 2 and 3, would be equally good.

In Berar land is valuable and the area under grazing has been reduced to its lowest limits ; consequently cattle manure is scarce. Experiments were, therefore, designed to ascertain what supplementary manures could be used with most advantage. In one series the manures compared were 64 mds. cattle dung, 64 mds. poudrette and 2 mds. saltpetre. Of these poudrette proved to be by far the most economical.

In a second manurial series nitrate of soda, superphosphate and sulphate of potash were tried singly and in combination, and sulphate of ammonia and calcium nitrate were applied singly. The superphosphate, sulphate of potash and sulphate of ammonia were drilled in at the time of sowing at the rate of 40 lbs. of phosphoric acid and 35 lbs. of potash and 20 lbs. of nitrogen per acre respectively. The nitrate of soda was applied as a top dressing at the rate of 20 lbs. nitrogen per acre. The outturns obtained are given below :—

| Manures. | Average outturn of <i>kapas</i> in lbs. from 1910-13. |
|--|---|
| 1 Nitrate of soda Superphosphate } | 660 |
| Sulphate of potash } | |
| 2 Nitrate and superphosphate | 679 |
| 3 Nitrate and potash | 563 |
| 4 Nitrate alone | 496 |
| 5 Sulphate of ammonia | 469 |
| 6 No manure | 403 |
| 7 Calcium nitrate | 491 |
| 8 Superphosphate and potash | 501 |
| 9 Superphosphate | 500 |
| 10 Sulphate of potash | 413 |

The soil is very responsive to nitrogenous manures. It would appear to be deficient both in nitrogen and phosphates but rich in potash. Acting on these results, nitrate of soda has been stocked for sale on the Akola Farm and about 4 tons of this fertilizer were sold to cotton growers last year; but the purchasers were advised to use it only to supplement a dressing of cattle-dung applied in the same year. If used alone the value of the increase produced will seldom cover the cost of the manure. Moreover, the deteriorating effect which this artificial manure has on the soil would almost certainly prove detrimental to the stiff clayey loam of the cotton tract after a time.

That both nitrate of soda and saltpetre can be applied at a profit to supplement a light dressing of cattle-dung is evident from the results of the series given below, in which the two fertilizers were applied as a top-dressing when the plants were about one foot high:—

| Treatment. | Average outturn of <i>kapas</i> in lbs. per acre, 1907-13. | Net profit due to manure in 1914-15. |
|--|--|--|
| 64 mds. cattle-dung + 10 lbs. nitrogen as nitrate of soda. | 649 | Rs. A. P. 38 5 0 |
| 32 mds. cattle-dung + 20 lbs. nitrogen | 596 | 25 8 0 |
| No manure | 333 | 30 0 0 |
| 64 mds. cattle-dung + 10 lbs. nitrogen as saltpetre. | 631 | |
| 32 mds. cattle-dung + 20 lbs. nitrogen as saltpetre. | 565 | 20 9 0 |

The application of the fertilizer has in this case always accounted for a considerable acreage profit and has at the same time accelerated the maturing of the cotton to which it was applied. When applied along with the more bulky manure its deteriorating effect on the physical texture of the soil is likely to be neutralized.

But the most useful experiment carried out from the practical point of view was that to determine the manurial value of cattle urine conserved by the dry-earth system, the urine being absorbed by a layer of 6 inches of dry-earth spread in the stalls.

| Manure applied per $\frac{1}{16}$ th acre. | Average outturn of <i>kapas</i> in lbs. per acre for 4 years. | Net profit due to manure in 1914-15. |
|---|---|--|
| Dung and urine of two bullocks for 30 days .. | 601 | Rs. A. P. 34 9 0 |
| Dung alone of the same animals for 30 days .. | 440 | 17 1 0 |
| No manure .. | 284 | |
| Their urine alone for 30 days | 444 | 16 0 0 |

The same manures have been tried for *juar* in which case urine has given an equally good account of itself. It would appear that the manurial value of a bullock's urine conserved in this way for either of the two staple crops of the tract is just about equal in value to that of its solid excreta. This finding has been recommended for general adoption and is being put into practice by many of the leading landowners. Owing to the high prices of cotton during the time these experiments have been under trial, heavy manuring has as a rule been profitable. But few of even the most enterprising cultivators yet realize how highly economical it is to manure their cotton lands with such locally available manures as cattle-dung and poudrette at present prices.

The results already obtained from the different experiments with cotton are of considerable scientific as well as pecuniary value. They have given us a much more accurate knowledge of the different phases of cotton cultivation than ever we possessed before: they have at the same time exposed the error in some of the rule-of-thumb methods commonly followed by cultivators. They have given the Department of Agriculture a foundation on which to build up future improvements. It is difficult to give any idea of the pecuniary value, to the agriculture of the provinces, of the lessons learnt on the Akola Farm, which are now being incorporated into the farming practice of the leading cultivators. Had the price of cotton been normal this year the introduction of *roseum* should have increased the farming profits of our cultivators by at least 10 lakhs of rupees, a sum which far exceeds the total expenditure on the Agricultural and Veterinary Departments.

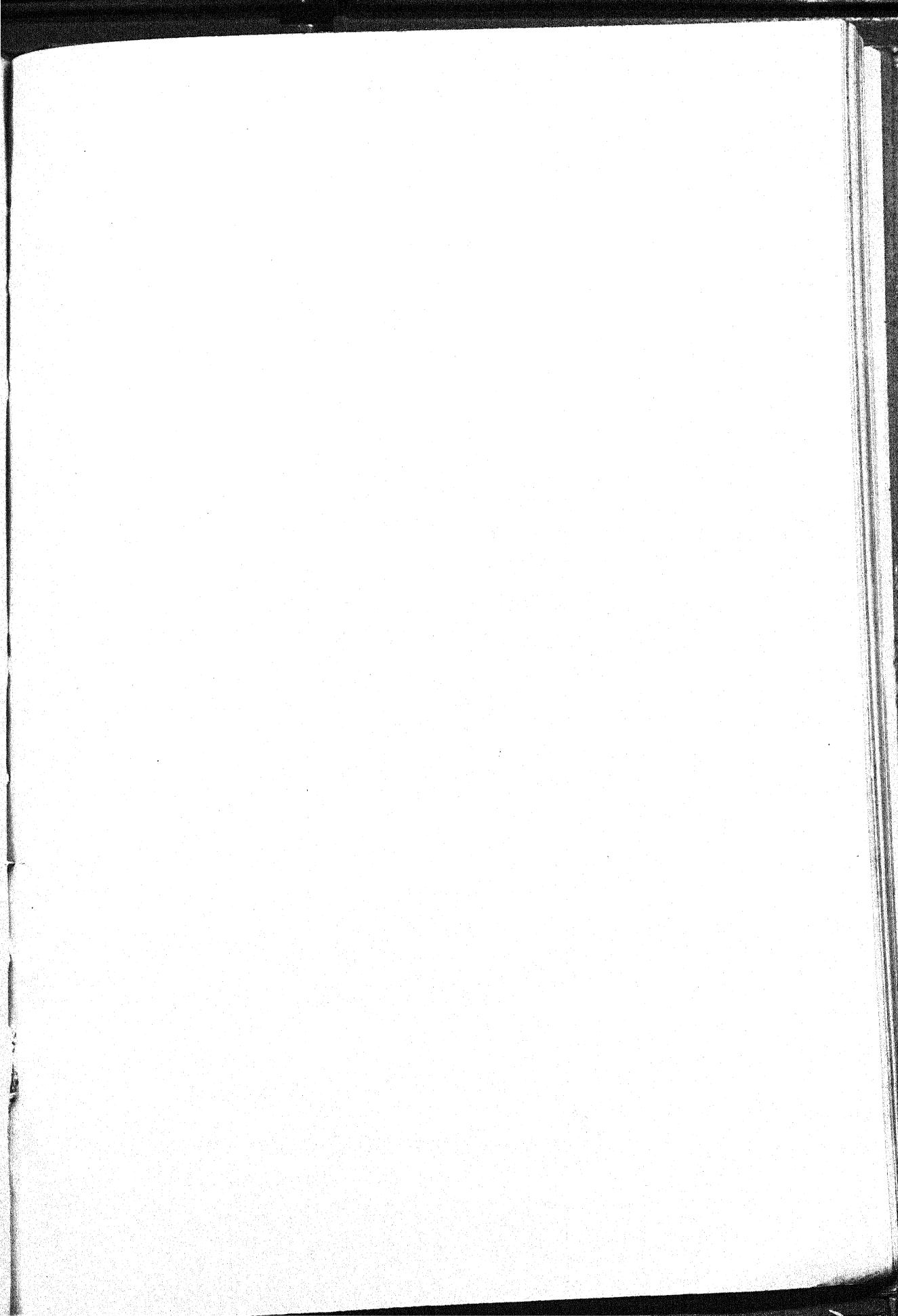
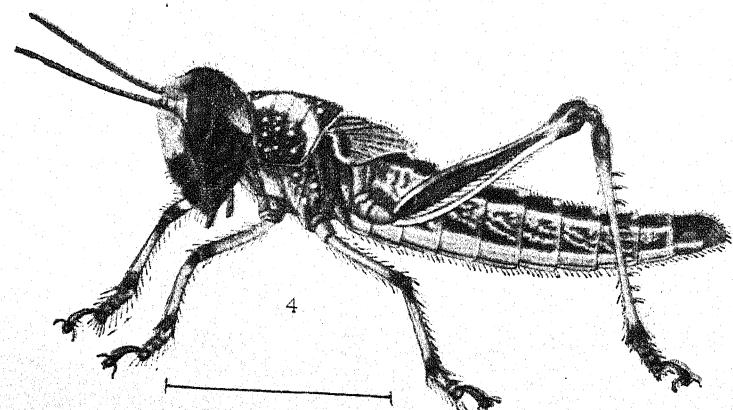
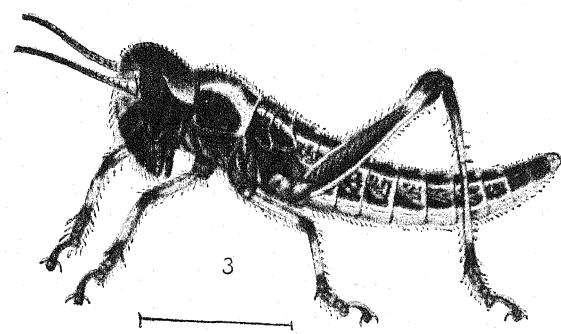
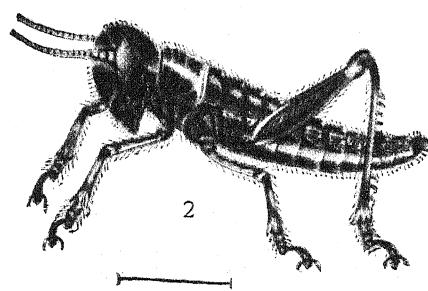
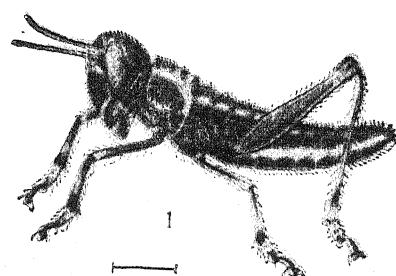


PLATE VII.



THE NORTH-WEST LOCUST.

EXPLANATION OF PLATE

EXPLANATION OF PLATE. From the plateau the flights most
nearly in favour. From the plateau the flights most
Baluchistan. The MIGRATOR locust where they find their way down
and thence into Upper and Lower Sind. *Schistocerca peregrina*. Lower Sind.
Schistocerca gregaria (Schistocerca) *peregrina*. Lower Sind. *Schistocerca*

and bears the name *(Schistocerca) porregrinum*.
At a comparatively recent date the means at our disposal for
Fig. 1. Migratory Locust Hopper, in first stage, magnified five times.
Fig. 2. Migratory Locust Hopper, in second stage, magnified four times.
Fig. 3. Migratory Locust Hopper, in third stage, magnified three times.
Fig. 4. Migratory Locust Hopper, in fourth stage, magnified two and a
half times.

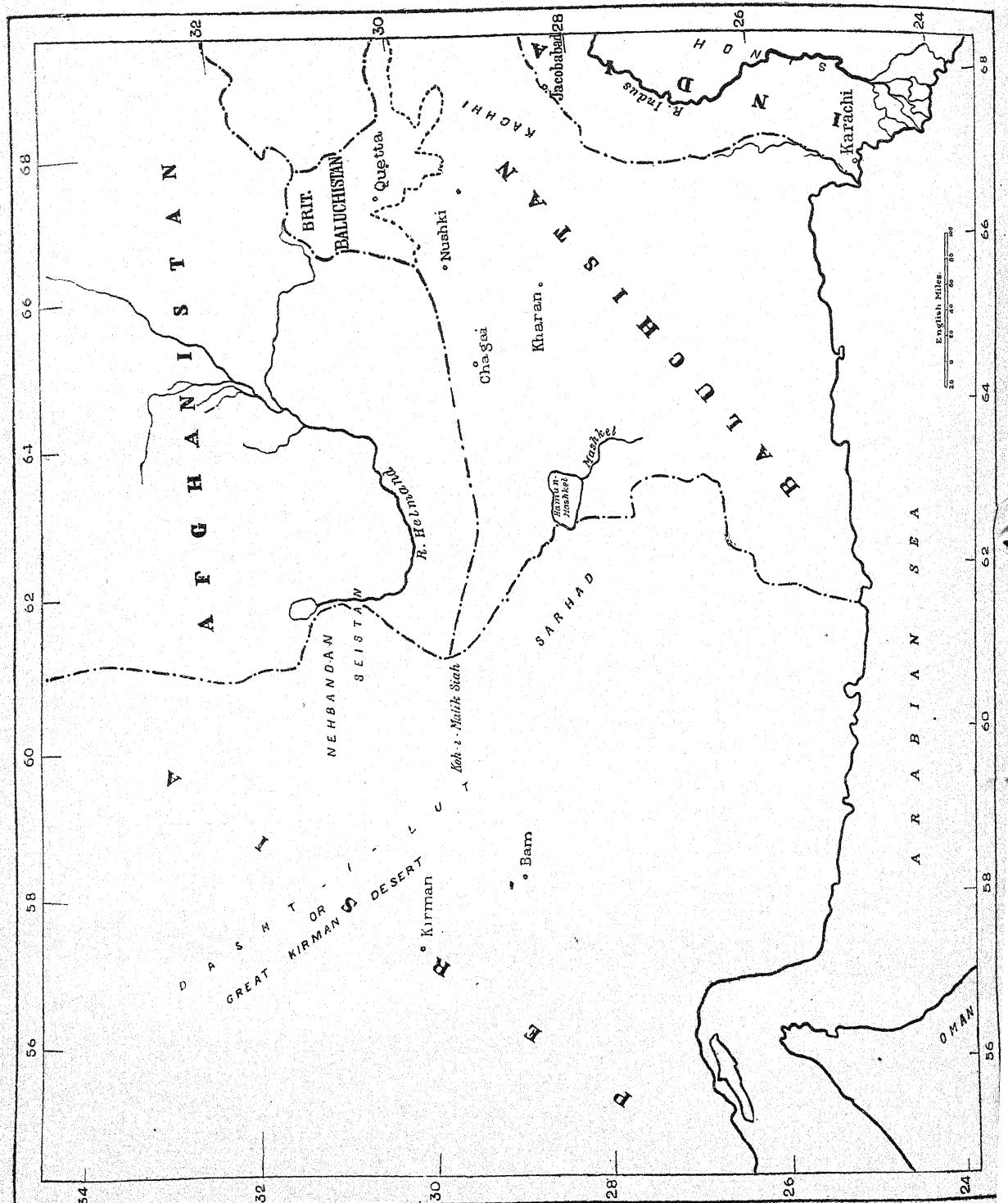
LOCUSTS IN BALUCHISTAN.

BY

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Political Agent, Chagai.

LOCUSTS appear in Baluchistan at intervals of every few years, always arrive after years of good rainfall, and as our records show, enter the province from the Persian side. The flights deposit their eggs in soft soil and for this purpose the Registan or "Country of Sand" is much in favour. From the plains, the flights move up into the Baluchistan hills, from whence they find their way down to Kachhi and thence into Upper, and, no doubt, Lower Sind. Up to a comparatively recent date the means at our disposal for ascertaining from whence these locusts came was insufficient. Following, however, the appearance of the first of last year's flights, steps were taken to trace them up, and the result of several months' patient investigation tended to show that the swarms had started from the Dasht-i-Lut or Great Kirman Desert, as it is also termed (*vide map below*). The precise breeding grounds in this Dasht were never actually traced, but as flights, coming from the same direction, made their appearance almost simultaneously in the Bam District, in Mashkel, in Kharan, in Sarhad, in Seistan, in Neh Bandan, and in the Valley of the Helmand, we may take it that the Lut breeding grounds embrace a very considerable area. In general characteristics, the *Acridium peregrinum*, which is our Baluchistan locust, closely resembles the *Acridium purpuriferum*, which is the locust whose depredations are a household word in South Africa. Both locusts appear after intervals which may extend to six or eight years: both appear after years of good rainfall: both deposit eggs under conditions relating to soil, climate, and moisture, which are identical: in both cases the hoppers, or, as they are termed in South Africa, the "voetgangers," pack into

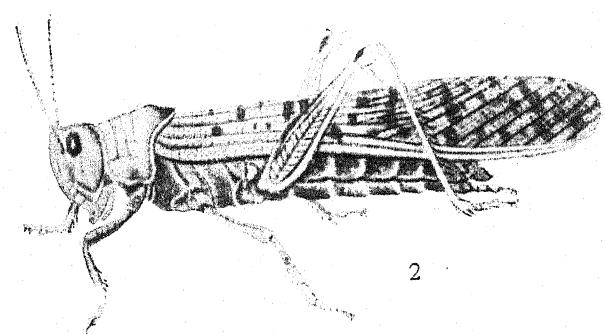
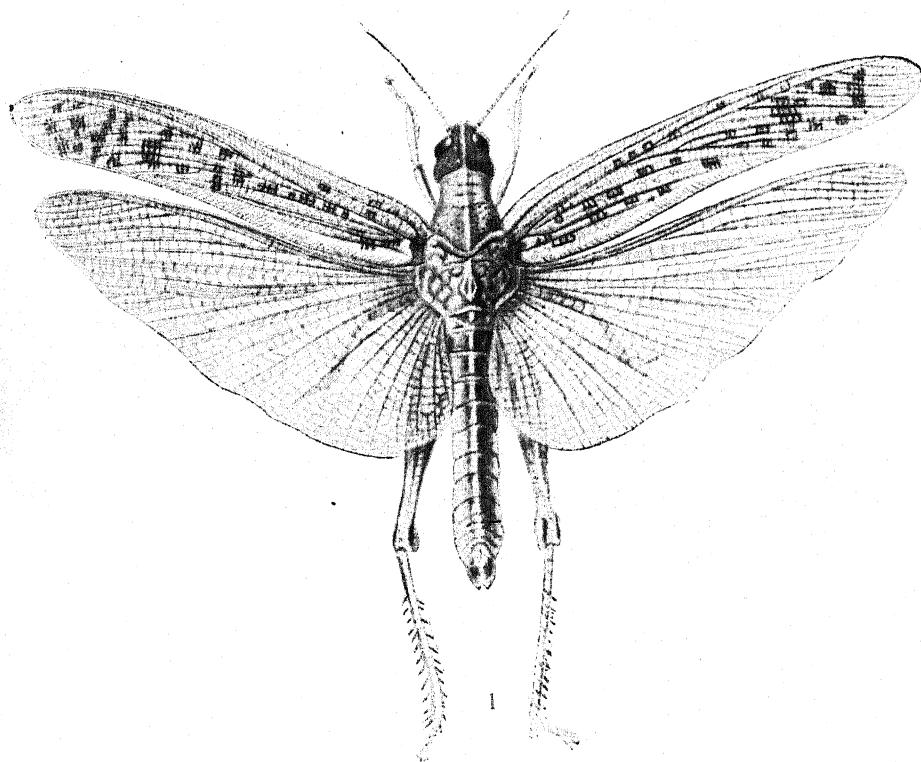


LOCUSTS IN BALUCHISTAN

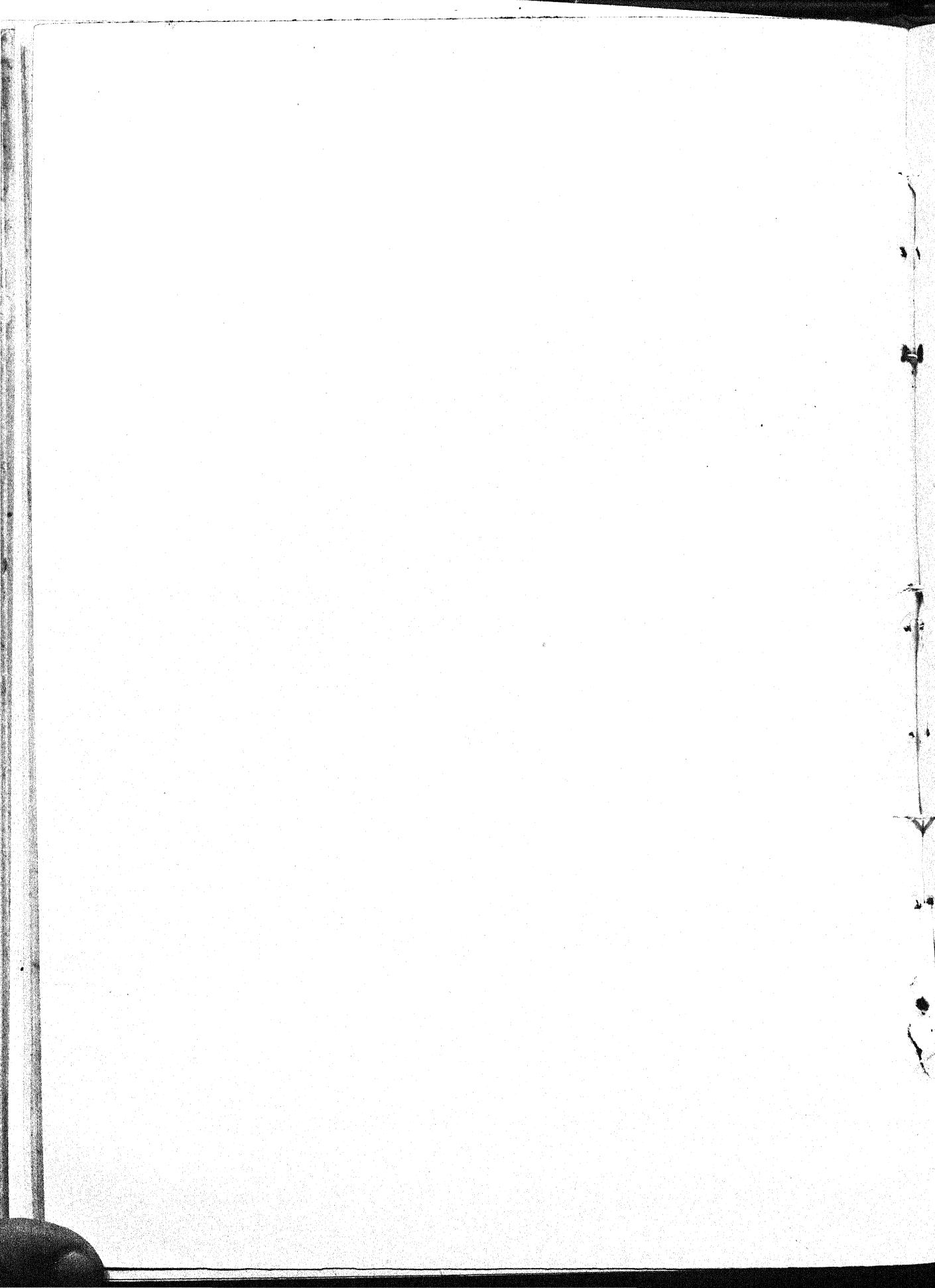
dense columns which move in a direction it is impossible to change, and devour all vegetation which comes in their way: both are essentially desert insects needing hot-dry climates for their breeding operations; and neither one nor the other are seen, except it may be sporadically, in places possessing moist damp climates. The *Acridium peregrinum* is widely distributed, being met with not only in Northern India and Persia but also in Arabia, Cyprus, and even in Algeria and Morocco. In yet one other particular the *Acridium peregrinum* now proves to resemble its African *confrère*. The investigations of the South African Government Locust Bureau have shown that the periodic locust plagues which scourge the South African colonies all radiate from the Kalahari Desert, that desert area which occupies the centre of South Africa. These investigations have also established the fact that locust eggs retain their vitality unimpaired for several years and that, to hatch out, they require moisture, combined with a heat of 90 degrees. The observations made, last year, in the Chagai District, brought to light the fact that the places selected by the parent swarms for the deposit of eggs were invariably in a soft, damp soil, and no case came under notice where eggs were placed in ground which did not fulfil these conditions. From the data now collected there is strong reason for supposing that the parent swarms of locusts which enter Baluchistan, at intervals of every few years, come from the Kirman Desert, and that this desert plays the same part in locust economy as does the Kalahari Desert in South Africa, forming a central breeding ground from which the parent flights radiate for hundreds of miles, and that for some unknown reason, but which is also found in the case of the Kalahari region, certain of these flights find their way back to the Great Kirman Desert to lay their eggs again and to start the whole vicious circle revolving once more. Once a parent flight has started out in the world on its career of devastation, what happens seems fairly clear. A suitable locality having been selected, eggs are deposited. This is done in the form of an egg pod which varies in length from 1—2 inches and which, in general appearance, resembles nothing so much as a section of

lead pencil. Pods contain some 70 eggs laid vertically, each egg being attached to its fellow by a gelatinous substance. A seer weight of eggs represents about a lakh of young locusts which gives about forty lakhs of these pests to the maund. Provided the weather conditions are favourable, the young hoppers hatch out in from ten to twelve days. Eggs hatch in succession, the result being a procession of minute red insects which, a few minutes after emerging from the ground and exposure to the air, assume a black, almost coal black, colour. The young hoppers make at once for the nearest vegetation, on which they start feeding. They pass through various moults, attaining maturity in about six weeks' time. Selecting a day when a strong wind is blowing in a favourable direction (and the important part which wind plays in the movements of these hordes is not, perhaps, quite fully realized) the young locust swarm launches itself into the air and starts, in turn, on its career of devastation. Locusts are understood to attain an age of three months, and during this time they mate and deposit eggs. From the investigations made last year, it was not quite certain whether the whole swarm deposited its eggs together or whether eggs are laid in a succession of favourable places, as the swarm forges ahead. The evidence seemed rather to point to the latter being the case, for a swarm known to have pitched and deposited eggs was found, later on, to contain many females distended with eggs. Each flight seems to be endowed with a determination to prolong the line of flight which was followed by the parent swarm and none of the flights which bred in Chagai, or Valley of the Helmand, last year, was known to have returned to Persia. The nomad Baluch collect quantities of females in egg and use them as an article of food, their practice being to parch them over a slow fire and store them in bags, until used. Locusts treated in this way are said to keep for four or five weeks and to form quite a nutritious food. It has been observed that once a locust visitation has started, it does not spend itself until the lapse of a period of from two to three years. This is probably ascribable to two main causes. The time must naturally come, as the flight advances depositing eggs and propagating its species, when the temperature

PLATE VIII.



THE NORTH-WEST LOCUST.



of the waning summer is not sufficient to hatch out eggs, and these have, therefore, to lie dormant in the ground until a new summer brings with it such conditions as are required. The other cause relates to the moisture which plays so important a part in the hatching of locust eggs, and which is evidently a special provision of Nature, for moisture accompanied by heat postulates the necessary supply of vegetable food for the young locust. Eggs will not hatch out unless kept well damped, and so it must frequently happen that the supply of moisture in the ground is exhausted by evaporation before the lower strata of eggs in each egg pod can hatch and, in such circumstances, these eggs must remain latent either until more rain falls or until the following Spring. The flights which enter Baluchistan make for Sind, and the question now arises, whether the locust visitations of Northern India and Sind which come round with such unfailing regularity are endemic, or are due to pulsations of locust energy which, starting from the Great Kirman Desert, spend themselves, in the course of two or three years, but not before each pulsation has wrought a devastation which is to be computed in lakhs of rupees. Locusts in the flying stage cannot be dealt with, and all that can be done is to prevent a flight settling on trees, gardens, or depositing eggs in standing crops. Given sufficient men, this task is not so difficult as would appear at first sight. If we assume the correctness of the theory that each parent flight starts from a common central breeding ground, it follows that if we can destroy the chain of life of each locust flight, we prevent the damage and loss which must otherwise ensue until Nature herself intervenes with climatic or other conditions which bring about the termination of the plague. If locusts cannot be dealt with in the flying stage, the matter is different when they are breeding and after they have hatched out. Prior to breeding, locusts assume a vivid yellow colour, quite different to the pinkish tinge they take on the last moult and before starting on their flight through the air. The appearance of yellow locusts, therefore, indicates that the flight is about to deposit eggs, and, where possible, steps should be taken to keep all such flights under observation. At this period the females are so

heavy and distended with eggs that they are unable to make long flights. On alighting on ground suited to the purpose, mating begins, and this is followed by the deposit of eggs in the soil. The female would appear to have the faculty of elongating her body for she extends it into the soil to a distance of about double its normal length. Grounds where breeding is taking place should, where possible, be marked out, by means of pillars, and as many people as possible should be set to work at once collecting eggs. A maund of eggs represents 40 lakhs of young locusts and the damage which 20 lakhs (if we allow 50 per cent. loss) of young locusts can do is very heavy.

If the breeding ground is near a village or crops and rewards sufficiently tempting are held out, it is sometimes not difficult to induce the villagers and their families to turn out and collect eggs. The quantity which one man, when he has acquired a little experience, can collect in one day is remarkable. The exposure of eggs to the direct rays of the sun for two hours, during the maximum heat of the day, has been found to destroy their vitality, and ploughing is thus a measure which can often be resorted to with advantage. It must, however, be observed that such destructive measures as these, together with those of a more mechanical type referred to later on can, with one exception, only be used when the flight is a small one and the eggs can be easily reached. When these two conditions do not exist, as is unfortunately so often the case, the only course which remains is to wait until the young hoppers appear and then to direct one's whole energy to their destruction. A series of experiments on locust destruction have been conducted by the Locust Bureau of the South African Government, and the result of these has been to demonstrate that poisoning with the preparation of arsenic, known as arsenite of soda, is far superior to egg collection or any other means of destruction. Experiments on the same subject, conducted by the Russian Government in Transcaspia, have resulted in the immense saving in crops from locust damage which the last decade has seen. The experiments conducted in Transcaspia are of particular value to us, for they were conducted under conditions which approximate closely to those found in

Northern India and Sind, and they indicate that, no matter how unfavourable the conditions relating to locality of the breeding ground may be, arsenite of soda can be employed with efficacy. This poison, mixed with molasses or sugar, is used as a spray, and if sprinkled on a narrow belt of vegetation or grass in front of a moving column of locusts, destruction follows within a period of four days. This method has not, so far as is known, been tried in India, but steps are now being taken to test it in Baluchistan. Another method of dealing with locusts, in the hopping stage, is to spray them with water in which a small proportion of soap has been dissolved. This clogs their breathing orifices and, second to arsenite of soda, has been found, perhaps, the most effective way of dealing with these pests, before they have acquired wings and taken to the air. There are various other ways of destroying young locusts. Shallow ditches provided with screens of American cloth are perhaps as good as any. Into these trenches columns of young locusts are slowly driven, and, as soon as the trenches are full, earth is either thrown in above and beaten down, or wood or grass sprinkled with kerosene oil is placed on top and ignited. In soft sandy soil, it has been found that cloth screens are not absolutely essential, provided that men, with brushwood brooms, are stationed on either side of the column so as to prevent the young locusts moving outwards away from the trenches. Another means which has been employed, in some places, with advantage is an axle, bored at intervals with holes into which brushwood brooms are inserted, and mounted on wheels. As the axle revolves, the brooms sweep the hoppers into a sack provided with a wide mouth, which is trailed along the ground. From time to time the bag is emptied and its contents burned. Hoppers pack at night under the bushes on which they have been feeding, and another means of destroying them is, therefore, to spray these bushes with kerosene oil and set them alight. Special instruments, called torches, can be obtained for this purpose. In some places it may be found advantageous to resort to this method of destruction, but it has the disadvantage of being both clumsy and expensive. To all mechanical means of locust destruction, other than spraying, one great disadvantage attaches, a disadvantage which,

it will be found, also exists in the case of egg collection, and this is that it postulates the employment of a very large body of men, if any really appreciable results are to be obtained. Now zamindars are, as a rule, supine and difficult to move, and although it may happen that some particular energetic District Officer may occasionally succeed in inducing his cultivators to turn out and combat these pests, yet the fact remains that the task is an uncongenial one, and rather than face the toil and trouble which a locust campaign involves they are prepared to see their crops suffer. The Indian is both by inclination and nature a fatalist, and he is apt to prejudice, at the start, any attempt to combat a locust invasion by believing that he is engaged in a hopeless struggle against impossible odds and a struggle which his forebears had always declined to face. In addition to this there is the further objection that the *Acridium peregrinum* is a desert locust and prefers to deposit its eggs in soil which approximates to desert conditions, and it follows that in the localities it favours for propagating its species, it is rarely possible to collect the number of persons necessary to carry on an efficient campaign. On the other hand, as has been found in Transcaspia, spraying offers no difficulty which cannot be overcome with a little trouble. It is inexpensive, needs a very few men to work, and these can conduct the campaign in places and under conditions which would, otherwise, be impossible. The requirements are merely a small machine fitted with a proper nozzle—that known as the Bordeaux nozzle gives the best results—the poison itself which is made up in drums, ready for use when mixed with water, and a supply of water which can usually be arranged for at little expense.

Note.—We have retained the names of these locusts as given in Colonel Webb Ware's manuscript, but would point out that the name *Schistocerca tatarica*, Linn., is used for *Acridium peregrinum* in Mr. W. F. Kirby's "Fauna" volume on Acridiidœ, whilst the name *Acridium purpuriferum* is given as a synonym of the South African Species, *Cyrtacanthacris septemfasciata*, Serv., in Mr. Kirby's Catalogue of the Orthoptera.—(EDITOR.)

SECOND REPORT ON THE IMPROVEMENT OF INDIGO IN BIHAR.

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I. INTRODUCTION.

THE results obtained, up to the end of 1913, on the improvement of indigo in Bihar were published by the Bihar Planters' Association in January of last year and copies were then distributed to the members. It is not proposed to recapitulate here the contents of the first report but to deal with the progress which has been made during the year 1914.

There are five main directions in which the indigo industry can be developed by scientific methods. These are as follows :—

- (a) The production of an ample supply of good, well-grown seed at the lowest possible cost and with the least trouble to the planter.
- (b) The production of the maximum yield of indigo and of *seeth* from the plant now grown.
- (c) The improvement of the plant by selection so that the yield of indigo and of *seeth* can be still further increased. The selection work, both on Java and on Sumatrana indigo, is in progress at Pusa and the results will be published next year.

- (d) The preparation of finished indigo, in a standard form of high purity, suitable for the Home dyers.
- (e) Indirect improvements, such as the production of more valuable cover crops for Java indigo and the discovery of methods of increasing the efficiency of *seeth* as a manure.

The present paper deals with the progress made in establishing the seed supply, in improving the yield of indigo and also in finding a more valuable cover crop for the Java plant. Nothing has been attempted in the direction of studying the manufacturing process with the view of discovering the best way of producing pure indigo-tin direct from the plant. This is not necessary for the local trade, but it will have to be taken up if natural indigo is to make any progress in the European market. One of the great advantages of the synthetic product is that it is easily manipulated in the vats, whereas natural indigo varies greatly in composition and dyeing power and therefore requires expert supervision. Under modern conditions of production, this is a great disadvantage.

II. THE MANUFACTURE OF INDICAN.

From the standpoint of the planter, the indigo plant is grown mainly for the sake of the indican in the leaves. There is a bye-product called *seeth*, which consists of the plant residues after extraction and which is a very valuable manure. In the manufacturing process, the green plant is steeped in water, the indigo is precipitated, collected into cakes, dried and sold as a dye. It is usual to apply the term manufacture to the process of converting the indican in the cut plant into indigo cakes in the factory. This, however, is not the whole matter as the indican itself has to be manufactured first of all by the growing plant. The present section deals with the manufacture of indican by the plant and with the conditions under which this process goes on. It will be clear that this is the centre of the whole subject and that *the future of the indigo industry in Bihar will depend, first and foremost, on the capacity of the planting community to apply the principles set*

orth below and make the plant produce the maximum amount of indican.

Indigo is a leguminous plant and, like all members of this order, is characterized by a high percentage of nitrogen in the seeds. This nitrogen occurs in the form of proteids and is placed there by the plant for the sole purpose of nourishing the seedling in the first stages of existence and supplying the protoplasm of its growing cells with nitrogenous food until it can lead an independent life.

When sown, the indigo seeds at first make no growth above ground beyond the two small seed leaves. All the development is subterranean in the form of roots, and, at a very early stage, and before the first real leaves are produced, swellings, known as nodules, begin to appear on the roots. Soon afterwards, indican can be detected in the first real leaves, but this substance has not yet been found in the seed. These root nodules are of the first importance in indigo (as in all leguminous crops) and, as will be seen later, everything in indigo cultivation and also in the separation of the indigo from the green plant in the factory, depends on the successful working of these root nodules¹ and of the roots.

The essential points about these nodules are two. In the first place, they contain bacteria (*Rhizobium*) which have the power of assimilating the free nitrogen gas of the atmosphere and working this up into materials from which the indigo plant makes the protein it requires and also the indican in its leaves. In a sense, the first stage in the production of indican is the nodule of the indigo root and the source of this indican is the nitrogen of the air. In the second place, the food of the bacteria in the nodules is supplied by the plant and, for this purpose, substances of the nature of sugar are passed down from the leaves into the nodule to feed the bacteria. The arrangement is a true partnership between the bacteria and the indigo plant. The bacteria produce from the air the materials

¹ The well-being of all leguminous crops in India depends on the aeration of the root nodules. It is true that the place of leguminous crops in agriculture has long been understood and the rôle of the nodule is now recognized. The agriculturist, however, does not always appreciate the needs of the nodule itself.

for making proteids and indican, in return the plant feeds the bacteria with sugars formed in the leaves. Leguminous plants, however, if grown in soil rich in nitrates, do not form nodules but absorb the nitrates direct in the same manner as other plants do. These essential facts of the work of the nodule, in the plant economy, must be clearly grasped at the outset as on this depends the understanding of this paper and the perception of the principles on which the improvement of indigo depends. It must also be remembered that those parts of the indigo root which absorb water and minerals also require air and will not work in the absence of oxygen gas.

The development and activity of the root nodules of indigo take place best when the plant is grown on somewhat poor land. On such land, the soil contains little nitrate, and, accordingly, the nodule factories are working at high pressure to supply the proteids required. Large amounts of the nitrogen and oxygen of the air are used up and the leaves of the indigo become rich in indican. Every planter knows that indigo grown on rather poor land (*zilla* indigo) gives the best yield of finished indigo and often the best colour. Poverty of soil in nitrates is one of the conditions for the production of numerous nodules on the roots and incidentally of high indican storage in the leaf.

When indigo is sown on rich land, containing a high proportion of organic matter such as *seeth*, the number of nodules formed on the root is small and the bacteria in them do not work at any great pressure. In such soil, nitrates are formed in abundance and the indigo plant then behaves like tobacco and takes up its nitrogen by way of the root hairs, in the form of nitrates dissolved in the soil water. Under such circumstances, the growth is rapid but little indican is accumulated and, if such plant is steeped, it gives a small proportion of indigo and moreover of poor quality indigo. This fact is also well known to planters and the inferiority of the crop from highly manured land, compared with *zilla* indigo, is understood by all.

The activity of the root nodules reaches its maximum about the time the plant is ready to flower. At this period, the leaves are

also rich in indican. At this time, however, the indican in the leaves begins to be called upon by the plant and to be utilized by the flowers and developing seeds. It is said that if the indigo crop bursts into flower, the yield of finished indigo will fall off and the colour will suffer.

The activity of the nodules depends on two main factors—a full continuous supply of air from the atmosphere and a supply of food from the leaves for the nodule bacteria. If either of these two things is interfered with, the nodule factory does not work. As regards the supply of air to the soil round the nodule, this is at first an easy matter in Bihar provided the surface soil is well and deeply cultivated and if crusts, formed by rain, are broken up whenever they occur. When the monsoon sets in, however, difficulties in the air supply to the nodules begin. If the monsoon is short and there are no large falls, the nodules get enough air and, if there is a succession of such years, the air supply in the soil is abundant and Java indigo reaches its maximum development. If, however, there is a heavy rainfall so that the soil is packed by rain and the air spaces destroyed and filled with water for long periods at a time, then the supply of the essential air to the nodules, and to the roots generally, is cut off and the activity of the whole root system, including the nodules, is stopped. At the same time, no further indican can be produced. When this happens, the whole economy of the plant is upset and it cannot manufacture any more food. A starvation period sets in and the reserves are called up. As at flowering time, there is an immediate run on the reserve indican and this is consumed. If the plant in this starving condition is cut, it will give a low yield of indigo, of poor colour just as flowering indigo does. As the starvation process proceeds, the plant begins to look unhealthy, the leaves fall and alter in colour and at last the stage, known as the wilt disease, appears. This is not a disease but the last phase in starvation, resulting from the destruction of the nodule factories and of the absorbing portion of the roots, the activities of which have come to an end. This has been brought about by the cutting off of the air supply by the heavy rains consolidating the soil and filling its pore spaces with water. This

cutting off of the air supply is not due altogether to the rain which falls direct, but is partly produced by the surplus water which runs off higher lands towards the low places. If this run off from other areas could be prevented, the damage could be lessened, and it is here that the Pusa method of drainage comes in to assist the indigo plant and the indigo industry. We should expect if the above is true, that indigo grown on land heavily manured with organic matter would show wilt sooner than indigo grown on poor land. The former has very little stored indican in its leaves and is not in a proper condition to withstand a famine. Experience shows that this is so, and that these heavily manured plants are very prone to wilt and even die off completely before the plants on poor land have used up all their stores and begun to show signs of the trouble.

Besides cutting off the air supply, the activity of the nodules can be interfered with if the bacteria in them are not fed by the plant. When young Java indigo, sown in August for seed, is cut down to the ground in October when about a foot high, practically all the plants die and very few shoot again. At this stage, little or no reserve food has been deposited in the roots and the nodules die of starvation. A few plants, however, just manage to survive and here again the new growth is wilted. At this stage, there is no reserve laid down and the whole plant rapidly dies of starvation.

The importance to the indigo crop of the nodules and of the absorbing roots is manifestly very great. Any interference with the partnership between the plant and the bacteria means a loss of indican and any serious trouble means the death of the plant, a condition which is reached through a wilting phase. The successful management of the indigo crop now becomes plain and simple and consists in running the nodule factory to its highest pitch. Not only is the yield of indigo thus increased, but the condition of the finished product is improved and good colour results.

III. THE IMPROVEMENT OF THE YIELD OF INDIGO.

It will be clear from the preceding section of this report that the improvement of the yield of indigo depends on the supply of air to the roots of the plant and to the maintenance of the aeration

of the soil. It will be equally clear that the present practices in Bihar in growing Java indigo are about the worst that could be devised and that, in the past, the indigo plant has never had a proper chance. There has been no attempt at proper cultivation and nothing has been done to increase the air supply by means of surface drainage. The crops obtained have been the result of chance ; sometimes the colour has been good but most frequently it has been poor and only a low price has been realized.

The improved methods of cultivation that should be adopted with both Java and Sumatrana indigo are indicated in this section.

Cultivation of Java indigo. This plant is usually sown in October under a *rabi* cover crop. As soon as the cover crop is removed, the surface should be broken up as deeply as possible by means of lever harrows.¹ In this way, the soil is aerated and a full supply of air finds its way to the roots. The indigo at once responds and new healthy growth takes place. This harrowing must be done as soon as the cover crop is taken off and before the land bakes and gets foul with weeds. It must be thoroughly done and two to three inches of fine soil must be left on the surface. Weeds are also removed by the harrowing and the moisture is conserved. The main object, however, is to supply the nodules with air so that they can make new growth and store up indican. Any crust which forms by rain must be broken up by the harrows, otherwise the air supply is cut off.

When the plants are large enough towards the end of April or early in May, the indigo should be cross-cultivated, as deeply as possible, with the five tine spring tooth cultivator.² A few plants may be uprooted, but this does not matter as the indigo must start the monsoon with as much air in the soil as possible.

¹ The best type of lever harrow to use is the two-section harrow made by the Massey Harris Company, Toronto, Canada, price 12.90 dollars, f. o. b., New York. The orders for these harrows should be pooled by the Planters' Association and the makers should be instructed to crate the wooden bars, otherwise these will disappear at Calcutta during the unloading process at the docks. One pair of Bihar cattle will draw these harrows easily.

² An agency for the supply of these cultivators has been established in Muzaffarpur. If the local supply is inadequate, orders should be sent to Messrs. Volkart Brothers, Lyallpur, Punjab.

The land on which indigo is grown should be drained by the Pusa system so that each field has to deal with its own rainfall only. This method was referred to in the last indigo report and it has been carried out, with great success, on the Dholi estate. Any planter can now see for himself this method in use on the large scale. This drainage system controls the rainfall and prevents waterlogging to a great extent. Consequently, under this method, the air supply in the soil lasts longer and the danger of wilt is diminished. Further, by keeping the nodules working by the increased air supply, the colour of the finished indigo will be improved.

The adoption of these methods in most cases will result in two good cuts of indigo. After this, the stumps should be dug up and the land put into *rabi* crops. If this is not done, the land gets foul with weeds. None of this indigo should, under any circumstances, be kept for seed.

Cultivation of Sumatrana indigo.—This plant is sown at the beginning of the hot weather, and, in order to bring the moisture near enough to the surface for germination, the land has to be compacted to a great extent. By this means the aeration of the soil is partly destroyed and the young roots are liable to suffer from want of air. As soon as the plants are large enough, they must be cultivated with lever-harrows and this must go on till about three inches of loose soil have been worked up. The root system of this plant is not so strong as that of Java indigo, so the spring tine cultivator should be used with care. After the first cut, the land should be worked up and aerated by means of the spring tine cultivator or the ordinary plough.

When sown on moist low-lying lands, the soil should be well cultivated beforehand so that there is a good supply of air. Any loss of moisture will make little or no difference as it is air—not water—which is important in such cases.

Pruning indigo at the first cut.—It will be clear, from the point of view of the plant, that the whole economy will be upset when it is cut down completely at the first cutting. The transpiration current will be stopped and the stumps will bleed. The nourishment of the bacteria in the root nodules will be interfered with and

a great deal of the reserve food of the plant will be taken away. A few leaves should be left to carry on the transpiration current and also the naked branches at the base of the plant. This is a great advantage in wet years like 1913, when at Pusa the total yield of leaf was increased by about 30 per cent. by this means. This method of taking the first cut involves no extra expense and only a little trouble in teaching the coolies. It is no advantage to take the old wood to the steeping vats, indeed, it is a positive disadvantage, as the cost of transport is increased and the concentration of the liquor is lowered. The *seeth* is also of less value. To the indigo plant, struggling to make new growth in semi-waterlogged conditions, the maintenance of the transpiration current by the few leaves left and the reserve food in the old wood make all the difference between life and death, and besides accelerate the new growth.

The methods of cultivation advocated in this section were partially put in force on the Dholi estate for the 1914 crop. The result was a record yield of 23·5 seers of indigo and of 170 maunds of green plant per bigha. This is only a beginning and still better results are easily possible.

IV. THE SEED-SUPPLY OF JAVA INDIGO.

An ample supply of well-grown seed of Java indigo is the first condition of progress in rehabilitating the Bihar industry. As pointed out in the first report, the area under this crop fell from 70,000 bighas in 1910 to 15,000 bighas in 1913 largely on account of the difficulty in growing the seed.

In connection with the seed-supply, it must be remembered, that Java indigo is a leguminous crop and, in common with other members of this group, the seed contains a high percentage of proteids. Leguminous plants assimilate atmospheric nitrogen in their root nodules and by this means manufacture substances which can be worked up into new proteids in the leaf. Until the nodules are formed on the young roots, they are dependent on the reserve proteid stored in the seed. On this account, it is essential that when leguminous seeds are sown they should be well ripened and

of good quality. Hence, too much attention cannot be paid to the seed-supply in indigo. With poorly matured seed, the seedlings have no proper chance of establishing themselves and an uneven crop, full of weeds, is bound to result. During the last few years, the quality of the seed sown has been very poor and this is one of the reasons why the crop has degenerated so markedly.

In the first report the following recommendation was made on the subject of growing seed :—

"The Pusa experiments on the growth of Java indigo for seed point to very definite conclusions. In wet years, like the present, a crop of really good seed is, as a rule, impossible after cutting the indigo for leaf. In future, leaf-growing and seed-growing should be regarded as separate things. For seed, Java indigo should be sown about the middle of August on high-lying well-drained lands. The seed should be sown in lines, about two feet apart, so as to promote branching and ensure abundant pollination. At first, cultivation and crust breaking should be carried out with the lever-harrow, but when the plants increase in size, inter-culture and weeding should be done by means of the Planet Junior hand hoe. Grown in this way, indigo escapes the so-called disease and large crops of good, well-grown seed can be obtained."

This method gave good results on the Dholi estate and a fine crop of seed was obtained in February 1914. The plants, however, were rather too thick, but during the present crop they have been thinned considerably and stand about nine inches apart. The result is shown in Plate IX, and it will be seen that an exceptionally fine crop has been obtained. The weight of seed will be determined and the figures published in the next report. As far as can be judged at the time of writing (December 16th), the yield of seed will not fall far short of ten maunds to the acre. Similar results have been obtained at Pusa this year and, as far as this method of seed-growing is concerned, the experiences obtained at Pusa and at Dholi in 1913 and 1914 are identical. There is no doubt that this method of growing seed is very satisfactory and that it should be adopted on all indigo estates.

The production of seed now offers no difficulty and yields of 8 to 10 maunds per acre can be obtained. High-lying lands, in a clean condition, must be selected for the crop, and it will be a distinct advantage if the field is drained on the Pusa system. Sowing must be done during the first half of August and the ordinary indigo drill, in which alternate shares have been removed, can be used. As soon as the plants are well established, the surface crusts should be kept broken with the lever-harrows. This is essential if the best results are to be obtained as indigo requires air for the root nodules and these nitrogen factories will not work properly if there is a crust (*papri*). About the middle of October after the *hathia*, the plants should be thinned by hand and they should stand about nine inches apart. The crop should now be cultivated as deeply as possible both ways with the five tine spring tooth cultivator, so that the upper four inches of soil are worked up into a fine mulch. On no account should this cultivation be omitted. Weeds are killed and the roots are given a full supply of air. The root hairs cannot work without oxygen while both oxygen and nitrogen are essential raw material for the nodules. It has been stated above that indigo seeds are very rich in nitrogenous reserve materials (proteids). This material is made by the plant from atmospheric nitrogen and the first stage in the process takes place in the nodules of the root. Air must therefore reach the nodule in abundance, and, for this reason, the deep cultivation for seed in early October is essential. If this is not done and the indigo plants are left in the hard, unbroken soil, it is observed that they set very few seeds and also begin to look unhealthy. The nodule factory cannot work for want of raw material and, in consequence, the supply of materials for the seeds is not available. The seeds are therefore not formed. A full supply of air to the roots is necessary for the production of a good crop of indigo seed.

As pointed out in the first report, the proper spacing of the seed plants is an important matter. The flower of Java indigo is a bee flower and the visits of these insects are necessary to bring about pollination. If the plants are too close together, they generally flower at the tips of the branches only and, even if flowers are

formed in the dense shade, the bees do not visit them. Air and light are necessary for the production of side branches, for the formation of flowers and for ensuring the visits of bees.

V. INDIRECT METHODS OF IMPROVING THE INDIGO INDUSTRY.

There are two indirect methods of improving the indigo industry, namely, the provision of a more valuable cover crop for Java indigo and the better utilization of *seeth*.

Cover crops.—As regards a better cover crop for Java indigo, a new variety of wheat, Pusa 4, has been introduced which can be grown with indigo on high lands. This wheat is a rapid grower, does not tiller much, has a very strong straw and is provided with few leaves. On this account, the young indigo plants get a full supply of light and air and the two crops do very well together. To give the indigo roots enough air, the mixed crop should be well cultivated in November with the lever-harrow, the tines of which should slope backwards so that none of the wheat is pulled out.

This wheat has been grown with indigo on the Dholi and Hathowri estates for some years and has done uniformly well. A general average of twenty maunds of grain to the acre can easily be obtained. The wheat stands up well and is easily cut by a reaper, while in threshing there is no trouble. The grain separates out easily in the machine and the sample is a very fine one. It is much liked by the people and round Bunhar and Hathowri the *raiyats* are taking it up. A large supply of this wheat is available for seed on the Dholi estate this year. This variety is likely to fetch a premium at the Calcutta mills, so an effort should be made by the Indigo Planters' Association to establish a grade of Pusa 4 in Bihar for the Calcutta market. Later, when the cultivation spreads, shipments to England can be made.

The efficiency of seeth.—As is well known, *seeth* is a very good manure for tobacco, but its value depends to a great extent on its power of aerating the soil and of giving the tobacco roots an ample supply of air. Experiments are in progress at Pusa with the object of getting a better return from *seeth*. Evidence has been obtained that if the tobacco lands are mixed with small pieces of tile (*thikra*),

the amount of organic matter for the crop can be reduced. The cost is not very great and a plot which was improved at Pusa in this way nine years ago still shows its superiority. If the present supply of *seeth* can be made to produce the same results on two or three times the area, the factories will be materially assisted and the indigo industry will receive an indirect benefit. The large scale experiments on this subject will be completed by the end of the present year and, if the final result is successful, the method will be brought to the notice of the planters.

On February 10th, 1915, a large number of the leading members of the Bihar Indigo Planters' Association visited Dholi in order to see the improvements, referred to in the above report, in indigo cultivation and in drainage, carried out on an estate scale.

The Pusa system of surface drainage was explained in detail and areas of the estate were shown which have been transformed by surface drainage in a single year. In one case, a large area, which previously gave little or no return, was seen in chillies, the rental of which is now ninety rupees per bigha. In another case, some of the land which had previously been rendered very infertile by scour, was seen under tobacco under a rental of one hundred and forty rupees a bigha.

There was a large area under Java indigo bearing a fine crop of seed and also mixed crops of Pusa 4 wheat and indigo. Lever-harrows and spring tine cultivators were shown at work. This visit was a great success and the demonstrations were followed and discussed with the closest interest. It is hoped that meetings such as this will take place every cold weather and that it will be found possible to combine visits to Dholi and to Pusa.

NOTES.

SPINELESS CACTUS.—In recent numbers of the Journal¹ there have appeared some accounts of the use made of prickly pear as a food for animals and of the difficulties experienced in getting rid of the spines in order to render the material fit for feeding purposes. It may therefore be of interest to some of the readers to know that some time ago the present writer came across several clumps of an almost Spineless Cactus near Mandalay. From all appearance it had been growing there, alongside the common spiny *Opuntia*, for a very considerable time and the only information that could be obtained regarding it was that it had been brought from Amarapura a few miles away and planted in its present position about the years 1888 to 1890. It would be interesting if one could ascertain whether the plant is really indigenous and whether it was known before Burbank produced his Spineless Cactus, but further attempts to obtain information have not been successful.

The plant when examined was of a duller green than the prickly pear around and although the small swellings or "cushions" (tubercles) exist they are free from spines. But on *some* of the cushions, particularly on the younger joints, there are a very few minute spinules. These spinules, however, are so fine that they are often scarcely perceptible to the touch and are also delicate enough to be rubbed off by hand and consequently easily got rid of. The "joints" are somewhat large, more regularly oval in shape, thicker and, as far as one can ascertain without careful experiment, at least as succulent as those of the ordinary spiny cactus. The situation is a very dry one and this may account for the some-

¹ *Agri. Jour. India*, Vol. IX, Parts II & IV, April & October, 1914.

what shrunken appearance of both the species when last seen. No flowers or fruits have yet been seen by the writer.

Owing to the fodder conditions of Burma and the small chances of scarcity, Cactus is very unlikely to be of any use for feeding purposes in this province and consequently experiments are not being tried with the plant. If, however, the Agricultural Departments of other provinces wish to experiment, arrangements will be made to obtain and forward a few cuttings.

The writer understands that trials of Burbank's Spineless Cactus have already been made in India but can find no record of results. The Cactus in question might lend itself to selection. The absence of spines and hairy tufts, the absence of even spinules from the older joints and the ease with which these, where they do occur, may be rubbed off, or otherwise removed, indicate that selection would be effective in producing a variety entirely devoid of armour. (E. THOMPSTONE.)

* * *

AN IMPROVISED STACKING APPARATUS.—The apparatus described below was used on the Bangalore Grass Farm during the harvesting season of 1913-14. It consists of an upright pole of 6 inches average diameter, 28 feet long, which is supported by a hinged tripod fixed to a movable collar clamped to the upright at a height of about 15 feet. The tripod consists of three poles of $4\frac{1}{2}$ inches average diameter, and 21 feet long each.

To the upright pole at a height of about 20 to 22 feet is clamped a projecting arm of $2\frac{1}{2}$ inches square iron, bent at the end into a ring of about 3 inches diameter. This arm projects about 18 inches from the pole and is made in the form of an inverted right-angled triangle of one piece of iron with a base 18 inches, side two feet long and the hypotenuse in proportion. The side two feet long is clamped with two clamps to the upright pole with the apex of the triangle downwards so that the base projects, and is supported by the hypotenuse—from the ring at the projecting angle of the triangle is hung a chain of three circular links made of one inch round iron, each link of about three inches internal diameter.

To the lowest link of the chain a pole of about $4\frac{1}{2}$ inches average diameter and 40 feet long is fastened from its centre by means of a winged clamp with a bolt of not less than one inch diameter passing through holes in the wings and the link. This long pole then hangs horizontally like a beam scale. To one end of the horizontal pole a hook on the end of a piece of short chain is clamped and two ropes, each about 30 feet long, are fastened about 2 feet from the end. To the other end another rope about 30 feet long is fastened.

The hooked end of the pole is pulled down to the ground by a man on one rope attached to that end and the bale is hooked on by the central wire, or the bundle of loose hay is hooked on by a piece of rope tied round it. The other rope attached to the hooked end of the pole is held by a man on top of stack. A man then lowers the unhooked end of the pole by pulling on the rope attached to that end, thus raising the bale, and when the bale has reached the height required, he moves round away from the stack, thus bringing the bale or bundle of hay over the stack. The man with the rope on top of stack assists him by pulling on his rope and guiding the bale.

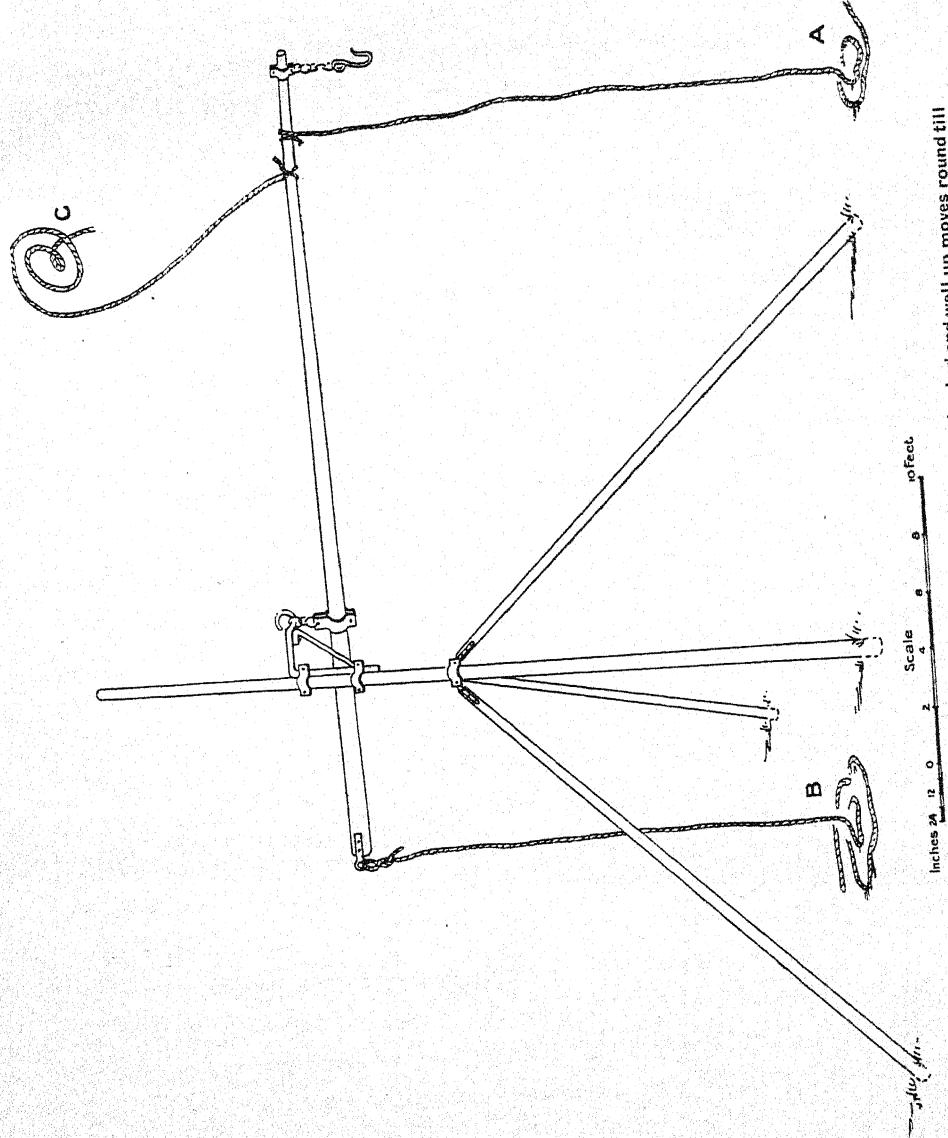
The bale is then unhooked and the pole is swung round away from the stack, and the hooked end again pulled down for a fresh load to be attached.

[As an alternative to the hook, a gripping appliance may be added in place of the hook at the lifting end. The arms of the gripper should be placed on each side of the bale, or, if the hay is loose, forced into it, and hoisted, when the gripper closes and holds the hay till it is lowered on the stack again.

This appliance will lift about 60 lbs. of loose hay at once. The hay should be cocked under the gripper and the two ends opened wide and forced into the cock as far as they will go.]

Instead of a 40 feet horizontal pole, a 28 feet tapered pole, tapering from 9 to 4 inches, may be used. It is hung at its centre of gravity and the hook end is the tip and the unhooked end the butt. The butt-end should be artificially weighted, if necessary, so that the centre of gravity will not be less than 8 feet from the butt. This will probably be found the most convenient arrangement,

SKETCH of STACKING APPARATUS IN USE ON BANGALORE GRASS FARM.
This shows the 28 butt ended tapering pole. The butt end to be sufficiently heavy to balance hooked end without load.



Sketch of gripping appliance
for use with Bangalore pat-
tern Stacker as an alterna-
tive to the hook.

Not to Scale

Joint to work
easily

Points sharp.

Arms made of $2'' \times \frac{1}{2}''$ flat iron
To be attached at "A" to hooked end of Stacker
in place of hook.

Inches 24 20 0 4 8 12
Scale 10 Feet

B keeping hooked end well up moves round till
clear of stack.

A then pulls down again.
3 coolies at A.

2 " " B.

3 " " C.

- A pulls down hook to ground and hooks on bale.
- B pulls downwards raising bale to above level of top of stack and then moves round till bale is over stack and then lowers.
- C on top of stack assists B to guide bale on top of stack and unhooks bale.

as a 40 feet pole of sufficient strength and lightness is hard to get.

Cost of apparatus.—At Bangalore, using casuarina poles, and having the iron work made in the Sappers and Miners' workshop, the total cost was Rs. 40.

Cost of stacking with apparatus.—

Loose hay.—A stack 120' × 30' × 18' containing 6 lakhs cost Rs. 23·7 per lakh pounds to make—labour required was three first class and five second class coolies. The stacking rate per lakh lbs. is approximately the same as that when the "Innes" elevator is employed, but while the cost of the "Innes" elevator is about £75 that of this apparatus is Rs. 40.

Baled hay.—A stack of 120' × 30' × 18' was erected at the cost of Rs. 7·13 per lakh pounds—labour required was seven first class and five second class coolies.

The apparatus was found to be capable of hoisting a bale of 100 lbs. on to the top of stack at the rate of about 1 bale every 40 seconds and stacking was therefore done very quickly.

A sketch of apparatus, also of the gripping appliance, is given on p. 183.

* * *

EXPERIMENTS ON THE PROFITABLE FEEDING OF MILCH COWS IN DENMARK.—These experiments take lucerne as a basal ration and are in the nature of a preliminary investigation as lucerne is of comparatively recent introduction into Denmark.

It would appear that lucerne was fed *ad libitum* to the groups of ten cows each and that the weight and milk yield of the individual cows did not stand in any approximately close relation to the amount of lucerne consumed.

This was followed by the introduction of an additional ration of 1·02 lbs. of oil-cake per gallon of milk which was given to group 1, while group 2 received an equivalent of oats, *i.e.*, 1·33 lbs. to every gallon. This oil-cake was fed to group 1 for 25 days and after that the experiment was reversed and oil-cake fed to group 2.

Despite the fact that the oats should have produced an equivalent amount of milk as the equivalent numbers were technically correct, the oil-cake in both groups produced the greater supply of milk.

From these facts the following conclusions were drawn, and in view of the fact that lucerne is now being extensively grown under irrigation for cattle feeding purposes and as a food for milch stock, they are of great interest.

1. Lucerne alone can only exceptionally and temporarily afford a profitable food for milch cows.
2. Lucerne combined with other foods is one of the best fodders for milch cows.
3. Under the given conditions, *i.e.*, when an economical ration was required for cows in good condition, the addition of oil-cake to lucerne was more favourable to the milk yield than the addition of a corresponding quantity of oats (on the basis of equivalents).

The following set of general rules may with advantage be given for the use of lucerne :—

1. As long as the lucerne is young it should be supplemented by roots or cereals.
2. For the succeeding two months it should be fed with oil-cake.
3. For the last month with oil-cake and roots.

[WYNNE SAYER.]

* *

The Queensland Agricultural Journal for December 1914 has a note on a simple method of preserving eggs from which the following extract is made :—

"The main object of preservatives is to prevent the air from penetrating to the inside of the egg. But this alone will not entirely avert putrefaction because the elements of putridity already exist in the pores of the shell. Consequently, to obtain a perfect preservation, it is necessary not only to prevent the atmospheric air from entering the egg but to retain the life-power of the organisms in it.

"The eggs to be preserved by the following process must first be carefully examined to see if any are cracked or split. Such eggs must be rejected. Then the eggs are placed in a bath of lukewarm water (95 degrees Fahr.), in which they must remain for 15 minutes. When taken out they must be well rubbed with a soft rag to remove all dirt particles from the shell. When they are clean, they are placed in a sieve and plunged for 4 to 5 seconds in boiling water, and at the expiration of that time they are to be taken out and cooled off in cold water and laid on a cloth to dry in the air. Care must now be taken that they are not rubbed by the cloth. As soon as dry, they must be placed in boxes, and packed in chaff, chopped straw, oakum, or such like material and put away in a dry, cool place. The packing material must be perfectly dry. By the immersion in boiling water for 5 seconds, the fungi and bacteria in the egg are all destroyed. At the same time, owing to the high temperature, a coagulation of the inner tissue which unites the shell to the skin of the egg takes place, by which the pores of the shell are closed, thus preventing any further infection. The main difficulty of the operations lies in the timing of the 5 seconds while the eggs are immersed in the boiling water and the care required to see that the packing material is absolutely dry. If the eggs are kept in longer than 5 seconds, it results that, especially in thin-shelled eggs, a portion of the albumen under the skin coagulates, and that no destruction of the fungus germ takes place. Hence the whole result depends entirely upon the immersion of the eggs from 3 to 5 seconds, preferably 4 seconds, in the boiling water. This method, owing to its simplicity and cheapness, is adapted not only to the householder or farmer but also for those dealing largely with eggs in their business. Eggs preserved in this manner have been proved to be perfectly fresh and good, and could not be distinguished either in taste or smell from fresh-laid eggs."—[EDITOR.]

* * *

THE WILLINGDON MILCH CATTLE SHOW AT BELGAUM.—As the supply of pure milk is getting more and more difficult in Belgaum as in other places, the District Agricultural Association

of Belgaum has resolved to hold a Milch Cattle Show annually or at regular intervals to encourage the breeding and improvement of milch cattle. At the suggestion of the officers of the Agricultural Department it has been decided that the Show should be confined to that type of milch cattle in particular which possess the rudiments for developing good milking strain and which will both breed and get good milking stock in the future. The prizes to be offered will be substantial so that they may produce the desired effect on the exhibitors. A Show was held in April last and His Excellency Lord Willingdon, who takes a keen interest in live-stock improvement, was pleased to allow it to be called after him. The Show was chiefly remarkable in demonstrating the very poor yield of the local cows and the vastly superior capacity of Sindhi cows brought to Belgaum by the Military Dairy. The largest quantity of milk given at the two milkings together was 18 lbs. The cow that gave this quantity was a Sindhi obtained from the Military Dairy Farm at Belgaum and was bred and reared in the locality. The other prize winners were of local breed and were declared by the judges to give good promise if well fed and attended to. A number of men now propose to buy Sindhi cows and one or more selected bulls and so lay the foundation of a good local milch breed. This is to be done under expert advice.—[EDITOR.]

* *

In the *Monthly Bulletin of Agricultural Intelligence and Plant Diseases*, Rome, for August 1914, there is an interesting article by Mr. C. W. Walker-Tisdale, on the dairy industry of Great Britain.

The author starts by comparing the value of milk as a food with its present price and shows that no other food of such nutritive value can be obtained so cheaply, and it therefore behoves the people to make every effort to keep milk at its present price.

After touching briefly on the way in which milk production is steadily ousting corn growing and stock feeding in England, some interesting figures are given showing the retail price of milk

in large towns and the way in which it maintains a steady price being about the only home-grown commodity which is absolutely free from foreign competition.

The author then deals with the question of milk production and its improvement by means of individual selection and his remarks have such an application to India that they may be quoted in full :—

“ The question arises as to what is being done to cope with the increased demand for milk and the possibility of the demand being greater than the supply. As previously mentioned, more and more arable land is being converted into pasture, which is the main requirement for dairy farming ; but apart from this must be considered the number of stock capable of being carried by the total amount of land available. Farming in Great Britain is still regarded as one of the less important industries, though there are many movements on foot at the present time to make it more productive and to increase the area of land available for agricultural purposes, by bringing under cultivation soil which at present is more or less unproductive. If, however, these points are left out of consideration, and it is assumed that the present available land is carrying practically all the stock it is capable of doing, which we think is by no means the case, there is still a means of increasing milk production. This is by means of increasing the yielding capacity of the dairy cows, or, in other words, devoting special attention to breeding and selecting animals for high yields of milk. A great deal of work is now being done in this direction both by individual dairy farmers and public bodies—work that ten years ago merited but little attention. If the average yield per cow, as is estimated for Great Britain, is only some 350 to 400 gallons, then it follows that much improvement is possible. Milk records are being carried out by various County Councils and Dairy Associations, the results of which show the quantity and quality of the milk yielded annually by each individual cow in the herd, and this information enables the farmer to retain only the cows which give satisfactory results.

“ In Scotland a number of Dairy Societies have been started and have been in operation some five or six years, with the result

that Milk Record Schemes of great value have been obtained and much growth in this is being continued. It is found that in most herds the variation in the annual yield per cow is great, for whilst the poorest animal may give 350 gallons or less, the best may be yielding 1,000 or perhaps more. Now the cost of keeping and tending an animal yielding a large quantity of milk does not much exceed that of a poor cow; hence if only good cows of tested capacity are kept, as much as 50 per cent. more milk may be obtained from a similar number of cows.

"Most dairy farmers, even men who have been engaged in the work for many years, seldom know the milk yield of each cow in their herds, and milk records have shown as wide a difference between two herds on adjoining farms as 200 gallons per cow. Thus the farmer whose herd average 600 gallons per cow per annum, may look forward by exercising care in selecting his cattle to increasing the yield to 800 in the course of a few years.

"Numerous dairy farmers, however, do not breed their own stock, but instead buy cows which they retain for one, two or three years and then sell them off fat to the butcher. The calves of such animals are usually also sold to the butcher, and this system of dairy farming tends to reduce the quantity of milking stock in the country and many of the best dairy cows are thus lost. Such may be considered a very extravagant method of dairy farming, and to the farmer in this case milk records do not appeal, as he does not keep his cows a sufficient length of time and does not retain any of the progeny, even of the best ones."

The paper then goes on to deal with the factory system of dairying run on co-operative lines and its satisfactory effect in preventing a glut of milk at certain times of the year, and after a few remarks on the tuberculous regulations and the forthcoming Pure Milk Bill which is shortly to become law closes with a set of statistics showing the amount of milk brought into London daily by rail and the amounts of cheese exported and imported by the United Kingdom each year.

The fact that over 221,442 gallons of milk are brought from long distances into London each day goes to prove that the methods of

cooling, sterilization and general treatment of milk are now so perfect that it should be possible to get pure milk almost anywhere, and this fact, with the assistance of the railway, should in time solve the milk question for most of the Indian cities, despite the disadvantages caused by excessive heat, slower trains and greater uncleanliness under which any undertaking of this kind in India would be bound to labour.—[WYNNE SAYER.]

* *

A suggestive paper on "The Organization of Co-operative Dairy Farming" was contributed by Mr. V. H. Gonehalli, Assistant Registrar of Co-operative Societies, Bombay Presidency, to the Co-operative Conference held at Poona in August 1914. It is well known that the dairy industry in India is in a very unsatisfactory condition and is in need of improvement. The reasons for this unsatisfactory condition are manifold. The dairy business in India is followed by cultivators and by professional milk-men (known as *gowlis* in the Deccan) who generally live in large cities and towns. Most of the latter do not own or rent land for cultivation; nor do they grow fodder crops for providing green food for their cattle in the hot season. They have, therefore, to purchase for their animals, grass, oilcakes, bran and other feeding stuffs at high prices. The manure produced by the animals is not profitably utilized. The *gowlis* as a class are poor and are in the hands of money-lenders who charge heavy interest ranging from 2 to 4 per cent. per month. There being no proper organization, the cost of marketing milk is out of proportion to the price realized. The result is that the milk yield not being heavy as a general rule, the *gowli* invariably adulterates it with water to make the business pay. The cultivators, also, who keep milch cattle do not grow sufficient fodder crops. The cattle are overfed with green grass in the monsoon while in the hot season they do not get sufficient fodder and lose condition. This irregular feeding is extremely bad and the result is that the milk yield is seriously affected.

The process of milking the animals is also insanitary. The pot in which the milk is drawn is simply washed with cold water which does not destroy the bacterial germs. Milk is drawn from udders with moist hands and water is frequently applied to the fingers in the course of milking. This practice contaminates the milk.

Thus, while the supply of milk and milk products is far from sufficient, the quality of what there is is bad. It is therefore necessary to devise measures not only for increasing the supply but also for placing the industry on a sanitary and economic basis.

The extension of dairying in suitable tracts and its proper organization will go far towards solving the question of deficient supply of milk and its products in this country. The conditions most favourable for dairy farming are an adequate supply of water and grass. Villages situated on the banks of rivers which do not dry up in the hot weather, localities where a plentiful supply of tank or well water is available and tracts commanded by irrigation canals are considered suitable.

As the system of agriculture practised in many parts does not necessitate the farmer's labouring on the land throughout the year, the dairy business would pay him as a subsidiary industry and would enable him and his family to utilize their spare time. Taking the case of a particular part in the Thana District, the author says that if a cultivator keeps three Surati buffaloes (of which one is replaced every year) and if he grows fodder crops on his land and carries on the dairy business on economic lines, he can make a net profit of at least Rs. 100 a year, *vide* the estimates given on the next page. In these estimates it is presumed that out of the three buffaloes two will remain in milk throughout the year, the average yield of milk of each buffalo being taken as 10 lbs. per day.

Even if we allow a small sum as payment for insurance of cattle, it would leave a good margin of profit which would amount to a few rupees more if the cultivator looked after the cattle and cut the grass himself instead of employing hired labour. But as the ordinary

| Expenses. | | Receipts. | |
|---|-----------|--|-----------|
| | Rs. A. P. | | Rs. A. P. |
| Concentrated food for two animals in milk for 8 months .. | 180 0 0 | Price of 7,200 lbs. of milk at 1 anna per lb. .. | 450 0 0 |
| Oil-cake for do. for 4 months .. | 30 0 0 | Price of one buffalo sold .. | 60 0 0 |
| Rent for grass land, cost of cutting, etc. | 45 0 0 | Price of two calves .. | 10 0 0 |
| Price of green grass bought during 4 months .. | 22 8 0 | Manure | 30 0 0 |
| Interest on the price of three buffaloes (Rs. 300) at 9 per cent. | 27 0 0 | | |
| Price of a new buffalo to replace the one sold | 100 0 0 | | |
| Wages of persons attending the animals | 45 0 0 | | |
| | 449 8 0 | | |
| PROFIT .. | 100 8 0 | | |
| TOTAL .. | 550 0 0 | TOTAL .. | 550 0 0 |

cultivator has not got the necessary capital for starting on this scale and, borrowing from money-lenders would deprive him of much of the prospective advantage, and as an organization is necessary so that the industry may be carried on under sanitary and economic conditions, the formation of co-operative dairy societies is advocated in localities, the suitability of which has been established by a thorough preliminary investigation.

Mr. Gonehalli suggests that the Society should collect capital by issuing shares each of Rs. 10 or more, raising loans and receiving deposits, the members of the Society being required to purchase a certain number of shares. It should advance money to its members at 9 per cent. interest. The sale of the milk and milk-products of the members should be undertaken by the Society for which it should charge a small commission. It should build a shed in the centre of the village where the members should be required to bring their cattle for milking under the supervision of a trained *mukadam* who would see that the milk-pots are properly cleaned. This precaution is especially necessary where whole milk is to be sold. The milk

should be collected by the *mukadam* and sent to the dairy room for sale. If there is no demand for milk in the neighbourhood, the Society should keep a separator and extract cream which can be sold as such or turned into butter or *ghee*. At present prices the Society will be able to sell these at a profit. The skimmed milk should be returned to the members as it is a nourishing food and can be converted into curds which are much liked by the people in this country. The proceeds of the sale, after deducting the commission, should be distributed to the members in proportion to the quantity of milk supplied by each. The expenses of the Society which should be kept at a minimum should be met from the amount collected as commission. The Society can help the members in purchasing fodders, oil-cakes, etc., at wholesale prices. District Local Boards can do a very useful piece of work by purchasing a good bull and handing it over to these societies for breeding purposes. Of course the societies should pay a part of the purchase price and be responsible for its maintenance. This will give an impetus to the improvement of the dairy breeds of the country.

In this connection it would appear that Government might also encourage dairy societies by giving them loans as they do now to co-operative seed societies and weavers' societies.

A co-operative dairy society of the type described above would be suitable also for villages, in the neighbourhood of towns, where cultivators are already keeping milch animals for supplying the needs of the urban population.

Mr. Gonehalli is of the opinion that the *gowlis* living in towns should be moved, stock and all, to suitable sites outside the town and organized into co-operative dairy societies so that arrangements can be made for the improvement of the industry on sanitary and economic lines. As an encouragement in such cases the municipalities might give aid in the form of sanitary accommodation and supervision at concession rates.

In conclusion, it is pointed out that the progress of co-operative dairy farming will not only be advantageous to the cultivators and the consuming public, but also lead to some improvement in the local system of agriculture.—[EDITOR.]

THE SEED-TESTING STATION AT DUBLIN.—*The Journal of the Board of Agriculture*, London, in its issue for October 1914 has an article on "The Improvement in the standard of Quality of Agricultural Seed in Ireland," in which a brief description is given of the Seed-testing Station at Dublin established by the Department of Agriculture and Technical Instruction in that country. It is reported that the Station is fully equipped with all the necessary requisites for the testing of agricultural seeds and, in addition to the usual germination incubators heated by gas, has an experimental incubating chamber heated and automatically controlled, on the Grundy system, by electricity.

The following extracts show the nature of the work done at a seed-testing station and the two important respects in which the principles followed at the Irish Station differ from the Continental practice.

"At a seed-testing station, as is well known, the seeds are primarily subjected to tests for (a) purity, and (b) germination. The purity test is determined by weight, all the seeds not of the kind named in the designation of the sample, such as weed seeds, etc., being removed from a weighed portion of it, together with other impurities, such as sand, dirt, or débris of any kind. By weighing these impurities and making a simple calculation the percentage of purity can easily be ascertained. The percentage of germination is determined by placing a given number of the seeds from which the impurities have been removed (at the Irish Station this number is not less than 500, and in certain cases is 900) under optimum conditions for growth, and counting how many of them sprout or germinate in a given period of time.

"Seed-testing stations have been established on the Continent of Europe for many decades, and some of them—notably the Swiss one near Zurich—make a point of testing samples for clients of all nationalities.

"Although in the main the principles adopted at the best of these Continental Stations are the same as those in vogue at the Irish Station, yet there are two important respects in which those of the latter station do not coincide with Continental practice.

"The first of these is in connection with the tests made of the larger and commoner grass seeds. At most Continental Stations in testing such seeds for purity, not only are the real impurities, such as weed seeds, dirt, etc., removed and weighed as such, but so are also all the grass seeds which do not, or appear not to, contain a kernel or caryopsis. Since the germination test is carried out on the pure seed after the impurities have been removed, it follows that by the Continental method the germination test is made on selected seeds, and that therefore (particularly in relatively inferior samples) the percentage of germination will be higher than if the sample were tested by the Irish method. By the Irish method the germination test is carried out on the grass seed just as it is sold to the farmer after only the real impurities have been removed, and the result gives a fairer indication of the quality of the seed in the matter of germination. Of course, as regards purity, the Continental method gives lower percentages than the Irish does.¹

"The second point of divergence is in the matter of controls. At the Irish Station there is tested side by side with every sample under examination a portion of a sample known as a 'control,' the germination of which is already known from previous repeated testings. If the control does not come up to its reputation when germinated alongside of the given sample, the test is discarded and a fresh one instituted. The 'control' sample, therefore, affords tangible and convincing proof of the perfection or otherwise of the conditions under which the germination test is being made. Owing to the fact that the best conditions for the successful germination of the commoner kinds of agricultural seeds are now so thoroughly well known from years of experimental work, it is found in practice that the failure of the control is of the utmost rarity; nevertheless its employment is a valuable safeguard against unforeseen and exceptional contingencies."—[EDITOR.]

¹ For fuller presentation of the arguments in favour of the Irish method, reference should be made to the following paper:

Pethybridge, G. H. "The Methods employed in Testing Grass Seeds," *Journal of Economic Biology*, Vol. VII, Pt. 2, June, 1912.

REVIEWS.

Indian Forest Insects of Economic Importance. Coleoptera.—
By E. P. STEBBING. London, Eyre and Spottiswoode ;
1914. Pages xvi + 648, 63 Plates and 401 Text-figures.
Price 15 Shillings.

IN copying the above title considerations of space have prevented us from transcribing the author's full description of himself as given on the title-page, but we cannot help remarking that Mr. Stebbing's name does not appear in any list of Fellows of the Entomological Society of London since 1906. In his preface (pages v—x) the author refers to a former booklet of his entitled *Injurious Insects of Indian Forests*, but—possibly through a sudden access of modesty—omits all reference to his *Manual of Forest Zoology*, that precious classic to which we always turn for a hearty laugh in the dullest moments of depression.

The book itself deals entirely with Coleoptera (Beetles) and is presumably devoted (as its title indicates) to those species which are of economic importance to Foresters. But the first thing which strikes the reader is that a large number of beetles are included which have nothing to do with forest trees at all, and which, therefore, seem out of place in a book of this kind. As instances of this we may specify four different beetles given as attacking peach (pages 122—124), three as attacking coffee (pages 124 and 351), two more as found on grape-vines (pages 242—280), one as a pest of orange (page 346), several on mango, plantain, plum, etc.

The first four chapters are devoted to a general discussion of beetles with reference to their economic status in forestry, the fourth chapter including a short (20 pages) account of methods for the control of Insect Pests. On page 52 we read, "In nurseries,

bundles of some succulent crop plant poisoned with dilute kerosene may be placed on the seed-beds before the young plants come up. Caterpillars such as the *Agrotis* will resort to these and be killed ;" regarding this we would remark (1) that it is not usually necessary to take measures against hypothetical root-feeders before the young plants come up, and (2) that *Agrotis* larvæ, far from being poisoned by crop-plants sprinkled with dilute kerosene, would carefully avoid such. Again, on page 55, the author tells us that "to prevent pests such as caterpillars moving up or down the trunk, bands composed of a sticky material such as molasses should be painted on the tree" : we at once ask, what would be the cost of such an application and would further inquire whether Mr. Stebbing has ever tried this ? If so, we should imagine that every ant and wasp for miles around must have hailed him as a benefactor and, like Oliver Twist, asked for more ! An insecticide emulsion which should not "be allowed to get on to the skin of the operator" (page 55) seems to place itself rather outside the range of practical use. The perusal of this chapter leaves the reader with the impression that the methods recommended are more theoretical than practical.

Chapter V gives a short account of the characters of Coleoptera as a whole. The student should also refer to Canon Fowler's Introduction to the Coleoptera in the "Fauna Series."

Chapter VI commences an account of the Beetles in systematic order, the first family dealt with being the Passalidæ (pages 66—69). In the general account of this family we fail to find any reference to the extremely interesting social habits of these beetles beyond a bald reference to the fact that the larva stridulates. With regard to this point we read that "the first¹ pair of legs are short, striated, and stridulating sounds are produced with them." Mr. Stebbing tells us on pages 67 and 68 that he himself found Passalid larvæ,

¹ It is, however, only fair to Mr. Stebbing to state that he is not alone in this error. Lefroy also states in *Indian Insect Life* that it is the first pair of legs which are modified and the present reviewer has also repeated this mistake, copying Lefroy's statement (though with some doubt) in the absence of specimens which had been sent to another worker who was studying this group.

so that presumably this is his own description. Canon Fowler, however, tells us (*Fauna of India, Introd. to Coleopt.*, p. 206) quite correctly that "the first and second pairs [of legs] are comparatively long, but the posterior pair is rudimentary," whilst Arrow gives a figure in his volume on Cetoniines (p. 12). Passing over this discrepancy regarding a mere matter of fact, we proceed to the first species noticed and find that its name is given as *Leptaulax darjeelingi*, Knw., with the reference "Knw., Nov. Zool. V., p. 298 (1898)", whilst its habitat is given as "Darrang, Goalpara, Assam. Also reported from Mungphu, Tenasserim." The correct name of this common beetle is *Leptaulax dentatus*, and it was first described by Fabricius in 1792; it was re-described under the name of *darjeelingi* in the *Deutsche Entom. Zeitschrift* in 1891 by Kuwert, and again diagnosed by this author in 1898, under the amended name *darjeelingi*, in *Novitates Zoologicae*, Vol. V., pages 297-298. Mr. Stebbing consistently uses the contraction "Knw." no less than seven times on pp. 67-69; it is therefore presumably not a printer's error. Is Mr. Stebbing unaware that this author's name is Kuwert, or is he merely careless of the correct usage? This beetle is common throughout the Eastern Himalayas, from Darjeeling to Assam and in Lower Burma from Pegu to Mergui, whilst it also occurs in China, the Malay Peninsula and the adjacent islands. The description given of this beetle, as of all the species of this family, seems useless; the Forester is not likely to do more than look at the figure given and to the Entomologist the description is inadequate for the recognition of the species.

The next species dealt with is given as "*Leptaulacides roepstorffi*, Knw.," from an unknown tree in the Andamans. The correct name of this insect is *Leptaulax roepstorffi*, Kuw., and it has also been found in the Eastern Himalayas, in Tenasserim and in Tavoy. We do not consider that the information given here will be of any use either to the Forester or the Entomologist.

The next species dealt with is *Pleurarius brachyphyllus*, Stol., which is recorded from Ootacamund. We have not found it there, although it is known from the Nilgiris, but we have found it not uncommonly in the Anamalais.

Then follows the genus *Basilianus*, of which we are told that "a species of this genus is common in the Eastern Himalayas." But we find no mention of *Episphenus (Basilianus) indicus*, Stol., and *E. (B.) neelgherriensis*, Perch., both of which are common in almost all the Hill Districts in Southern India.

The last species of this family mentioned is *Aceraius hirsutus*, Kuw., the reference given being "Knw., Nov. Zool. V., p. 343 (1898)," whereas this beetle was also described by Kuwert in 1891. The only locality given is Darrang (Assam), but this insect occurs throughout the Eastern Himalayas from Bhutan to Assam and in Upper and Lower Burma as far south as Tavoy; also in Cambodia, Hainan, the Philippines and Formosa.

We have gone through this family species by species because it is a small group, the first one treated in this book, and therefore presumably to be accepted as a fair sample of the whole. We consider that one page would have been ample to devote to this group and that a single good figure (such as No. 35), with a general note on the bionomics of these beetles, would have been sufficient to enable the Forester to recognize a specimen as belonging to this group, which is all that he wants to do. If, on the other hand, the book is intended as an entomological text-book, the omission of such common species as *Episphenus indicus* and *E. neelgherriensis* seems inexplicable.

We could go through the whole book and doubtless find similar material for criticism in almost every family dealt with, but considerations of space prevent us and we will only call attention to a few of the more obvious errors and omissions which we have noted.

Page 17.—"Dichrocisis" *leptalis* should be *Dichocrois leptalis*; this mis-spelling is repeated in the Index and is therefore not a mere printer's error. Similarly, *Trachylepidia* "*fructicasiella*" should read *T. fructicassella*; probably it had failed to strike Mr. Stebbing that the name was applied to this moth because its larva feeds on the fruit of *Cassia*.

Pages 13 and 89.—We are inclined to doubt whether *Oryctes* grubs do really destroy Casuarina seedlings or ever feed on living plant-food at all. The evidence adduced here, on the reports of two

Forest Officers, does not seem sufficient and we suspect that Cock-chafer grubs were really referred to.

Page 22.—There seems to be little value in a statement such as the following:—"A species of *Meteones* is parasitic upon the caterpillar (*Tinea* sp.) defoliating the Kharshu oak, *Q. semicarpifolia*." To the Forester these names mean nothing without fuller descriptions and recognizable figures, to the specialist the information given is too vague to be of any use at all. We assume that *Meteones* is a mistake (not misprint, as it is repeated in the Index) for *Meteorus*, and we doubt strongly whether the larva of any species of the genus *Tinea* ever "defoliates" any tree, since the larvae of this group are rubbish-feeders as a rule although a few species mine blotches in leaves.

Plate VIII purports to show stems of *Poinciana regia* "girdled by *Xylotrupes gideon*" which is described on the opposite page, but without any reference to its early stages although the larva is figured in Canon Fowler's *Fauna* volume (page 214). We should like further evidence regarding this twig-girdling habit; meanwhile we rather doubt it and suppose that these twigs were girdled by *Sthenias grisator* or some similar species.

On page 92 the Cetoniine beetle *Oreodorus gravis* is referred to as a "weevil," although on page 393 the Curculionidæ are correctly designated as weevils.

Page 95.—*Anthia sexguttata* (also figured in *Indian Insect Life*, by the way, though the fact is not noted nor the beetle figured here) is also common in Southern India.

Page 119.—Lefroy's note on *Silvanus surinamensis* is quoted, but there is no reference to the fact that this species is figured in *Indian Insect Life*, although the student would doubtless appreciate a note to this effect, seeing that it is not figured here.

Page 126.—Neither of the two Dermestidæ mentioned are forest insects.

Page 151.—Peradeniya is not spelled "Peradiniya." On page 214 also we find a locality in Ceylon quoted as "Hovonapotani," a name which we do not recognize.

REVIEWS

Page 196.—*Catoxantha bicolor*, Fb., is here recorded from Pyinkadu and doubtfully from Sal. This beetle has proved an occasional serious borer pest of Cacao in Java [see Zehntner, *Bull.* No. 1, *Proefstation voor Cacao te Salatiga* (1901), p. 8].

Page 237.—The date of Fabricius' *Supplement* (quoted under *Gonocephalum depressum*) is 1798 and not 1789.

Pages 238-239.—The references to *Tribolium ferrugineum*, *T. confusum* and *T. castaneum* are not likely to assist the student to discriminate between these three forms, and it seems very doubtful whether Mr. Stebbing has really done so himself. A reference to Blair's paper (*Ent. Mo. Mag.*, 1913, pp. 222-224) may be recommended.

Pages 247-248.—The eggs of the beetle described here as *Mylabris pustulata* are stated to be "laid in bunches on the leaves of shrubs and grass stems near the ground;" we have obtained eggs from numerous species of Meloid beetles and have always found them laid either in or on the soil, and never on leaves or stems. When Mr. Stebbing says that he has watched these beetles "feeding on the fruit of a species of *Artocarpus* in Dehra, peeling and stripping the pericarp down to the stone," it becomes difficult to follow his statement, seeing that fruits of *Artocarpus* have no stone.

Page 249.—The account of *Cissites testaceus* would have been more complete if it had included a reference to Bugnion's paper on the life-history (*Bull. Soc. Ent. d'Egypte*, 1909, pp. 182-200, tabs. 1-3).

Page 358.—*Caelosterna "scabrata"* was named "scibrator" by Fabricius and there appears to be no good reason to alter its name. Similarly *Batocera "rubra"* was called "rubus" by Linnaeus.

Page 366.—*Batocera albofasciata*. The only reference is to deGeer's original description written in 1775. Surely the student has a right to demand references to literature within the last century. Possibly Mr. Stebbing is unaware that this beetle has been described and beautifully figured in all stages by Dammerman (*Mededeelingen van de Afdeeling voor Plantenziekten*, No. 7, De Boorders in *Ficus elastica*, pp. 4, 10-17, t. 1, f. 1, t. 2, ff. 1a-f.). A reference to Sorauer's

Handbuch der Pflanzenkrankheiten (1906-1913), p. 501, reveals further information and references.

Page 375.—*Olenecamptus bilobus*, Fb. The references quoted are Fabricius' original description and Lefroy's *Indian Insect Life* (twice erroneously quoted as *Indian Insect Pests*). The distribution is given as "Dehra Dun; Gangetic Plains." The student may therefore be surprised to find that this beetle is stated by Dammerman (*l.c.* p. 8; t. 2, f. 4) to be widely distributed in *Ficus elastica* in Java and Sumatra also, and we think we are entitled to demand a fuller account of its distribution from a book which is expected to "have a wider sphere than that of India and Burma."

Page 379.—Lefroy's note on *Glenea spilota* is quoted, but the reference is twice misquoted as *Indian Insect Pests* instead of *Indian Insect Life*. In line 21 the word "died" should read "dried."

Page 393.—From the author's statements regarding the size of weevils it would appear that five to six millimetres in length is quoted as a minimum size. The student will find many weevils much smaller than this.

Page 414.—*Paramecops farinosa* is noted on *Calotropis* from the Punjab only. It is not evident why this species is included at all in a book on Forest Insects and as a matter of fact it occurs commonly, not only in the Punjab, but also in the North-West Frontier Province and in Madras and probably wherever *Calotropis* grows throughout India.

Page 415.—*Eugnamptus marginellus* is another non-forest insect, only recorded from mango. No reference is given to the original description, which will be found in *Deut. Ent. Zeit.* 1898, p. 299. The same remarks apply to *Cryptorhynchus mangiferae* and *C. gravis*, both of which attack only mango fruits and both of which are unprovided with any references to literature.

Page 446.—*Odoiporus longicollis* is stated on very slender evidence to attack the coconut palm; we doubt whether it is ever a real pest of palms, though it is well known in most parts of India and Burma as a pest of Plantain. To describe the beetle as "light

"brown" is misleading ; the colour is very variable, from light brown to pitchy black, but most specimens are black. The student will find the synonymy of this species in *Ann. Soc. Ent. France* (6) V. 288 (1885) ; it is figured in *Indian Insect Pests* (p. 27) and *Indian Insect Life* (p. 382).

The book as a whole reminds us of the English alphabet, being at once redundant and defective. There is a vast amount of what can only be described as perfectly useless "padding," consisting of unnecessary repetitions (compare the two paragraphs on damage to seeds on pages 17 and 43), lengthy extracts from letters of Forest Officers, the inclusion of numerous insects which cannot be described as Forest Insects by any stretch of the imagination, and the devotion of pages to information regarding insects which cannot be identified either by the Forester or the Entomological expert because they are neither named nor even figured. The references given are very defective ; thus, under *Oryctes rhinoceros* the only literature cited is (1) the original description by Linnæus in 1758, and (2) a note by Mr. Stebbing. Considering the extensive literature, both in and outside of India, on this destructive pest, this omission seems to indicate a vast gap in the author's information. Similarly the references quoted under *Rhynchophorus ferrugineus* (page 444) are very meagre and by no means up to date. In many cases, even the original references are either not given at all under the species cited (e.g., pages 174-176, 181, etc.) or are defective (e.g., page 287) or are incorrect (e.g., p. 67). It is not apparent why several genera and species (see pages 405, 407, 412, 418, etc.) are described as "gen. nov." or "sp. nov." respectively, seeing that they were described as novelties previously to the appearance of this book and the original descriptions are even cited here.

When we say that most of the text-figures are the work of Mr. H. Knight, little more remains to be said regarding these ; but some of the other figures are very poor and some indeed—we may instance numbers 125, 150, 157, 159 and 274—are atrociously bad. Figure 143, of *Belionota prasina*, is not good and would have been more recognizable if done on a larger scale. The Plates are generally good and many are excellent ; Plates XI and XXXVI, however,

are much below standard and the former is a great contrast to Plate XV, which is excellent.

The Index would have been more complete and convenient if the insects dealt with had been indexed under their specific as well as their generic names.

This book is stated to have been published by order of H. M.'s Secretary of State for India in Council, and on page 249 the author indicates that at least another volume is in preparation. If this is so, we can only express a hope that a process of condensation may be rigorously insisted on and that the author may confine his attention to insects which are really pests of forest trees ; and we would further suggest that it would probably make for accuracy if his proofs were checked by competent experts before publication.

—[T. B. F.]

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Zeitschrift für Angewandte Entomologie, Vol. I, Part 1; pages 1-240, 2 Plates, a Map and 61 Text-figures. Berlin ; April, 1914. (Price for the whole volume 20 Marks.)

DURING the last few years there has been a good deal of interest taken in Germany in the subject of Applied Entomology mainly under the energetic leadership of Dr. K. Escherich, and this new Journal is brought out as the official organ of the recently founded German Society of Economic Entomologists. There are two articles on *Peritymbia (Phylloxera) vastatrix* in Prussia and in France respectively, followed by a note on racial differences between the forms of this insect found in Lorraine and in the South of France. Other articles describe the progress of Applied Entomology in Italy and in Germany and also in the German Colonies. This last, by Dr. G. Aulmann, is illustrated by twenty-five text-figures, most of which we remember to have seen before in this author's series of papers on the Fauna of the German Colonies ; both series seem likely to suffer from want of material in the future. Professor E. Zander gives a short but well-illustrated account of the Government Apiary at Erlangen. Dr. Teichmann provides a paper on the Biology of Tsetse Flies, illustrated by two Plates from rather indifferent

photographs, and other articles are on the Bionomics of Tachinid flies, the Mulberry Scale (*Diaspis pentagona*) and its parasites, the value of Insectivorous Birds, and on African Silkworms.—[T. B. F.]

* *

The Fodder Problem in the Bombay Presidency, published by the Government of Bombay, September, 1914. Price 2 annas.

THIS pamphlet deals with the different attempts which have been made to utilize the surplus stock of fodder from some parts of the Presidency to relieve the scarcity of fodder in others. This has been attempted in two ways; (1) by transport of natural grown grass at specially low rates on the railways; (2) by fodder storage (a) in stacks, (b) by ensilage.

The flaws in both these schemes are discussed in the pamphlet and various alternative methods are proposed, some of which seem likely to succeed.

New sources of fodder such as cotton seed hulls and prickly pear have been experimented with and the scientific selection of fodder grasses is recommended, as also the growth of fodder crops such as Bersim or Egyptian Clover under irrigation, while a combination of the various available fodders in certain proportions is also discussed.

But it would seem to hark back to one end which is that "the *raiyat* must be taught that it is worth his while to cultivate part of his holding with a crop for his cattle's consumption rather than to grow commercial crops over the whole area," and in this would seem to be the solution of the problem to a great extent.

To sum up the whole matter, it is merely a case of finding out how long it will take the *raiyat* to discover that it pays to keep cattle in good condition and fit for work, as they are an essential link in his farming, and, when he learns their value, not from a purely stock point of view, but from the value of the crops which can only be produced through the work they perform on the land, then he will be able to gauge the amount of land which he must set aside to feed his cattle, not regarding it as so much arable land wasted

from a food-producing point of view, but as a portion of his holding devoted to paying an insurance policy against famine and its results on his stock.

For this insurance policy to be paid by others will merely postpone the ultimate day when the *raiyat* will become an independent farmer and not as at present an individual whose methods of living on himself in good seasons force him to live on Government whenever a bad season comes along.—[W. S.]

* *

Sugarcane, its Cultivation and *Gul* Manufacture—By J. B. KNIGHT, M. Sc.—Bulletin No. 61 of the Department of Agriculture, Bombay. Price Annas 5 or 6d.

THIS bulletin deals with the varieties, cultivation, manuring, irrigation, crushing of the cane, boiling of the juice, its conversion into *gul* and the diseases of the crop. It refers mostly to the conditions existing in the Bombay Presidency and chiefly within the trap soil area. It is almost a complete guide for cane cultivation and *gul* manufacture, and on comparison with the same Department's previous Bulletin No. 25, it reveals the progress made by the Department towards the solution of various problems connected with this crop. *Gul* in Bombay Presidency usually sells at about 15 lbs. per rupee and it therefore pays the cultivator to manufacture *gul* rather than sugar. But the increase in the area under canal irrigation in the Deccan may in course of time make it necessary to convert some of the produce into sugar owing to the fact that the *gul* market is not likely to expand much. Until that time comes, however, there is a large amount of work to be done in popularizing the best methods of cultivation and *gul* manufacture worked out on Government farms. How paying the cultivation of this crop is in parts of Bombay is best seen in the following quotation:—

“The cultivation of sugarcane in the area under the canals is conducted on a very intensive system and crops are obtained which compare favourably with those of cane cultivation in any

part of the world. The net profits from the cultivation of this crop under canal irrigation are from Rs. 100 to 200 or more per acre : so it may be considered as a highly remunerative branch of agriculture for India where the average cultivator of cotton may get a net profit of Rs. 25 or 30 per acre. The margin of profit with food-grains is very low."

In connection with the manuring of this crop, the following remarks by the author will be read with interest :—

" When Mr. Mollison commenced the study of sugarcane, his first attention was directed towards the reduction of the amounts of manure and water then given to the crop. In his time he found that the cultivator frequently applied 750 lbs. of nitrogen per acre, and while admitting that only 100 lbs. of this element was required by the crop, he at first recommended that 500 lbs. be used. Later he conclusively proved that it was possible to raise maximum outturns with only 350 lbs. of nitrogen. Since his time we have been able to demonstrate that if the water-supply is regulated and carefully reduced to almost half the amount usually applied, a dressing of manure containing 250 lbs. of nitrogen will produce an equally good crop of cane.

" It is thought that with more extensive use of improved implements, which mix the manure more intimately with the soil, better methods of planting which reduce the quantity of water and the use of more available forms of nitrogen like mineral salts, the quantity of nitrogen required to produce a first class yield of cane, will more nearly approach that actually taken up by the crop, for in no part of the world is nitrogen so ruthlessly squandered as in the Deccan along the canal sugarcane tract."

It is interesting to record the author's conclusions in connection with the planting of canes arrived at after 10 years' work at the Manjri Farm. They are (1) that sets from " plant " cane are superior to those from " ratoon " cane, (2) that when all small and shrivelled sets are rejected a better crop will be produced, and (3) if only the terminal sets (*i.e.*, the three or four internodes just below the point where the leaves are lopped off at harvest) are used for

planting they will produce more vigorous growth of cane than sets of any other part of stalk. This is also more economical as this part of the cane is lower in sugar content than the rest of the cane. By this method not only is there less loss of sugar, but the remaining juice is improved by the elimination of this part of the cane and will produce higher quality of *gul*.

It is a sign of healthy progress that iron mills have to a great extent replaced the old wooden mills. It is stated that while the Nahan mill has less capacity and costs more than the Poona mill, a horizontal roller mill, known as "Pearl," for sale by Messrs. Club-walla & Co., is reported to extract about 8 per cent. more juice and to give otherwise more economical results.

The practical instructions given for boiling the juice and the manufacture of *gul*, together with the factors which affect quality of this product will, it is hoped, be of great use to those for whom they are intended. We will conclude with a suggestion that the Bulletin might with advantage be translated into the vernaculars of the Presidency if this has not already been contemplated and copies distributed in the tracts where cane is a substantial crop.—[EDITOR.]

* *

The value of Castration of Deccan Bullocks.—By J. B. KNIGHT, M. Sc., Professor of Agriculture, Poona.—Bulletin No. 62 of the Department of Agriculture, Bombay. Price As. 3 or 3d.

THIS bulletin appears to have been written principally with a view to remove the prejudice which prevails in the Deccan and Southern Maratha country against early castration of bulls not required for breeding purposes. In Gujarat castration of bullocks is practised when they are a year old while in the Deccan and Southern Maratha country this operation is postponed till they become five years old. Thus while Gujarat bullocks, although powerful and very active, are quite docile, those of the Deccan are rather difficult to manage and this militates to a large extent against the essential thoroughness required in working the areas used for intensive

cultivation such as cotton. The improvement in the breed of cattle becomes difficult in these parts as immature bulls are allowed to graze with the herd and to serve the cows. It is a popular belief in the Deccan that late castration develops the hump and promotes hardiness in the animal. The author describes an experiment made by him to test these points. His conclusions are as follows:—

1. That early or late castration does not materially affect the weight of the bullock.
2. That there is greater proportionate development in the hind quarters of early castrated animals.
3. That the strength is not impaired by early castration.
4. That the docility is markedly improved by early castration.
5. That activity is greater in early castrated animals.
6. To offset this the late castrated animals are perhaps better looking to some observers.
7. There is no proof of greater hardiness for late castrated animals.

As the Agricultural Department is trying to introduce improved implements and improved methods of husbandry, the necessity for more docile and active animals increases every year.

The sooner the cultivators realize the value of early castration, the better will it be for all concerned.—[EDITOR.]

* * *

Substitutes for Rab.—By J. B. KNIGHT, M. Sc.—Bulletin No. 63 of the Department of Agriculture, Bombay. Price As. 3 or 3d.

It may be mentioned at the outset for the information of the readers of this Journal that, within the tract of trap soils of Bombay Presidency where the rainfall is heavy, it is the custom to prepare the seed beds for rice by burning some substance like loppings of trees, dried grass or dung upon them before sowing the seed. This

substance is called *rab*. The seedlings are, when ready, transplanted to the fields which usually receive no manure. It may be noted that the yield from a treated plot is about 800 lbs. grain and 1,000 lbs. straw per acre, while that from an untreated plot is about 355 lbs. grain and 640 lbs. straw. It has been found that of all the substances used as *rab* cow-dung is the best, *ain* (*Terminalia tomentosa*) branches next to it and that leaf and grass are very inferior substances for *rab*. Investigations have also shown that the value of the *rab* is not dependent merely upon the manurial matter found in the ashes, but is to a large extent due to the heat. This practice may have originated in the ease with which branches of trees, etc., could be obtained in earlier times from the neighbouring forest at a trifling cost as the whole family of the cultivator did the work themselves and thus without any outlay reaped the advantages of increased crop production. But as in these days loppings of trees have to be brought from long distances and burning of large quantities of cow-dung cakes is not to be encouraged, experiments were made by the author to find cheaper and more efficient substitutes for *rab*, and the Bulletin under review records the results of these experiments. These may be summed up in the words of the author as under :—

That fish, nitre, sulphate of ammonia and oil-cakes are the most promising and that these may be safely advocated in the following quantities :—

Fish 120 lbs. per *guntha*¹ of seed bed.

Safflower cake (80 lbs.) 1 maund per *guntha* of seed bed.

Niger, Karanj, Ryan 120 lbs. (1½ maunds) per *guntha* of seed bed.

Undi 150 lbs. per *guntha* of seed bed.

Poudrette and sheep folding should be advocated wherever possible. The use of the former needs encouragement. Poudrette varies very much in composition, but about one cart-load per *guntha* should be applied. Nitre should be applied at the rate of 20 lbs. per *guntha* of seed bed and sulphate of ammonia at the rate of 15 lbs.

¹ A *guntha* is equal to one-fortieth of an acre.

REVIEWS

Cow-dung rotted and well mixed with the soil at the rate of one small cart-load per *guntha* is to be recommended.

The following table briefly indicates the value of each of these substitutes :—

| Rank. | Name of substitute. | Average outturn in lbs. | | Quantity to be applied per <i>guntha</i> of seed bed. | Cost per acre of rice. | Cost per maund (80 lbs.). |
|-------|-----------------------|-------------------------|----------|---|------------------------|---------------------------|
| | | Grain. | Straw. | | | |
| 1 | Fish Poudrette .. | 1,703.75 | 2,099.25 | 120 lbs. | 7 9 11 | 0 5 8 |
| 2 | Poudrette .. | 1,207 | 1,331 | 200 to 300 lbs. .. | 1 12 9 | 0 2 2 |
| 3 | Safflower cake .. | 1,457.3 | 1,653 | 80 lbs. .. | 7 7 0 | 0 6 3 |
| 4 | Sheep folding .. | 1,300 | 1,750 | 140 sheep for three nights. | 23 5 0 | 1 7 0 |
| 5 | Niger cake .. | 1,446 | 1,432 | 45 lbs. .. | 22 15 0 | 1 4 5 |
| 6 | Well rotted cow-dung. | 1,146.6 | 1,188.2 | 600 lbs. .. | 17 6 9 | 1 3 5 |
| 7 | Sulphate of ammonia. | 1,141 | 1,105 | 15 lbs. .. | 20 0 0 | 1 6 5 |
| 8 | Nitre .. | 1,050.8 | 1,253.5 | 10 lbs. .. | 12 0 0 | 0 14 7 |
| 9 | Urine earth .. | 1,020 | 1,009 | 1,000 lbs. .. | 6 6 0 | 0 8 2 |
| 10 | Household ashes | 787.5 | 1,199.5 | 132 lbs. .. | 18 0 0 | 0 14 0 |

[EDITOR.]

* *

An Improved Method of making Jaggery.—By ALFRED CHATTERTON, C.I.E., Director of Industries and Commerce, Mysore, Printed at the Vokkaligera Sangha Press, Bangalore.

THIS bulletin—No. 21 of the Mysore Industries and Commerce Committee—describes a system of furnaces and evaporatory pans designed by Mr. Chatterton to deal with the comparatively large amount of cane juice expressed by a mill, with rollers 12" x 18", driven by a 12-h. p. oil engine.

Such a mill, the author says, 'will easily deal with a ton of cane per hour, and the actual cost of working, including interest and depreciation, with an oil engine using liquid fuel or with a gas engine running on suction gas produced from charcoal, will not exceed As. 6 per hour'—about half the cost of crushing a ton of cane by bullock power.

Setting off this saving against the increased cost of carting cane from a larger area to a single centre, the advantage of the power

mill in juice extraction—estimated at a minimum of 10 per cent.—is left as clear profit.

An incidental advantage is the saving effected in time, enabling the cane on a proportionally larger area to be cut before it becomes over-ripe.

The necessity of designing an improved system of jaggery making arose from the inefficiency of the indigenous methods, when conducted on a large scale; in the author's words—'The ryot invariably employs a large shallow pan placed over a fire place constructed of mud, and for fuel uses the dried megasse from the cane crushing, and the trash from the cane field. With fibrous canes, this is usually sufficient, but when it is not so, he scours the neighbourhood for combustible material, and seldom, if ever, incurs any direct expenditure on firewood. The size of these open pans varies greatly in different parts of the country, ranging from a capacity for 250 lbs. of juice, to as much as 1,100 lbs. The usual time taken to convert the juice into jaggery is from five to seven hours. With a bullock mill yielding less than 300 lbs. of juice per hour, two pans will suffice; but, with a power driven mill treating one ton of cane per hour, and worked both day and night, at least 12 pans will be required involving the employment of one fireman to each pan, and two shifts of firemen in the course of 24 hours. Our experience with cane milling under such conditions has been extremely unsatisfactory; it proved impossible to properly control the firemen, the boiling was irregular, and the megasse from the mill insufficient, so that a very large expenditure on firewood had to be incurred.' In addition to reduced working costs per maund, the new system has been found to give an increased outturn of over 16 per cent. of jaggery from the same quantity of juice. The cost works out at about As. 4 per maund, on a basis of 12,000 maunds of jaggery per annum.

These figures should enable a rough idea to be formed of the possibilities of the application of similar methods to the manufacture of *gur* in Upper India; a sidelight is, however, thrown on the conditions obtaining in Mysore by a reference to the value of cane at Rs. 15 per ton—about double of its normal value in Bihar. It must

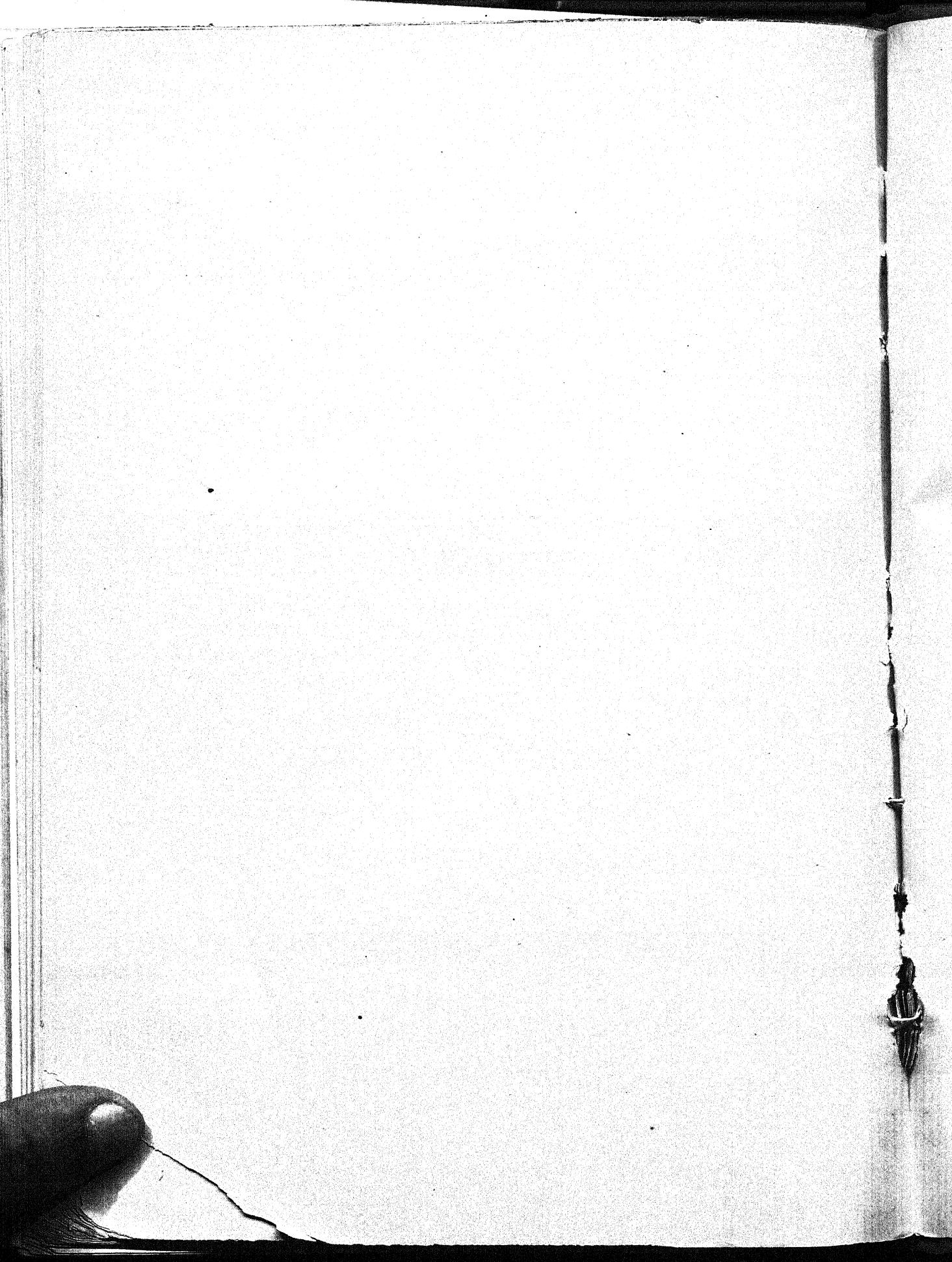
also be remembered that it is possible in Southern India to grow more than twice the weight of cane per acre obtainable in the North.

Nevertheless the progress made in Mysore augurs well for the solution of the similar problem in the United Provinces.—[A. C. D.]

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Report of an Agricultural Tour in Europe, America, and Japan during 1912-13.—By L. C. COLEMAN, M. A., PH. D., Director of Agriculture, Mysore. General Series, Bulletin No. 4 of the Department of Agriculture, Mysore State. Printed at the Government Press, Bangalore.

THE report is full of interesting observations and, keeping Indian problems always in view, Dr. Coleman has evidently gathered a large amount of information that will be useful, as regards, e.g., the organization of demonstration work, the carrying out of crop experiments, soil moisture investigations, and the control of the silk-rearing industry.



LIST OF AGRICULTURAL PUBLICATIONS IN
INDIA FROM 1ST AUGUST, 1914, TO
31ST JANUARY, 1915.

| No. | Title. | Author. | Where published. |
|-----------------------------|--|--|---|
| GENERAL AGRICULTURE. | | | |
| 1 | The Agricultural Journal of India, Vol. IX, Part IV, and Vol. X, Part I. Price per Part, Rs. 2; annual subscription, Rs. 6 or Rs. 6d. | Issued from the Agricultural Research Institute, Pusa, Bihar. | Messrs. Thacker, Spink & Co., Calcutta. |
| 2 | Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist) for 1913-14. Price Annas 8 or 9d. | Ditto | Government Printing, India, Calcutta. |
| 3 | Fourth Report on the Introduction of Improvements into Indian Agriculture by the work of the Agricultural Department. Price As. 2. | Ditto | Ditto. |
| 4 | Estimates of Area and Yield of Principal Crops in India, 1913-14. Price As. 4. | Department of Statistics, India, Calcutta. | Ditto. |
| 5 | Annual Report of the Department of Agriculture, Bengal, for the year 1913-14. Price As. 7 or 8d. | Issued by the Department of Agriculture, Bengal. | Bengal Secretariat Book Depôt, Calcutta. |
| 6 | Krishi Samachar for 1320 B. S. in Bengali. Price As. 6. | Ditto | Ditto. |
| 7 | Annual Report of the Department of Agriculture, Bihar and Orissa, for the year 1913-14. Price As. 8 or 9d. | Issued by the Department of Agriculture, Bihar and Orissa. | Bihar and Orissa Government Press, Patna. |
| 8 | Annual Reports of the Agricultural Stations, Bihar and Orissa, for 1913-14. Price Re. 1 or 1s. 6d. | Ditto | Ditto. |
| 9 | The Preparation of Silage in Pits, Leaflet No. 2 of 1914 of the Department of Agriculture, Bihar & Orissa. | N. S. McGowan, Deputy Director of Agriculture, Bihar and Orissa. | Government Press, Gulzarbagh. |
| 10 | Agricultural Journal (published half yearly). Vol. II (Double No.) Price Re. 1. | Issued by the Bihar and Orissa Department of Agriculture. | Bihar and Orissa Government Printing Office, Patna. |

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

| No. | Title. | Author. | Where published. |
|-----------------------------------|---|--|--|
| <i>General Agriculture—contd.</i> | | | |
| 11 | Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1914. Price As. 8 or 9d. | Issued by the Department of Agriculture, United Provinces. | Government Press, United Provinces, Allahabad. |
| 12 | Report on the Cawnpore Agricultural Station for the year ending 30th June 1914. Price Re. 1 or 1s. 6d. | Ditto | Ditto. |
| 13 | Report on the Partabgarh Agricultural Station for the year ending 30th June 1914. Price As. 8 or 9d. | Ditto | Ditto |
| 14 | Report on the Attarah (Banda) Agricultural Station for the year ending 30th June 1914. Price As. 6 or 6d. | Ditto | Ditto. |
| 15 | Report on the Benares Agricultural Station for the year ending 30th June 1914. Price As. 6 or 6d. | Ditto | Ditto. |
| 16 | Crop and Season Report of the United Provinces of Agra and Oudh for the year ending 30th June 1914. Price As. 8 or 9d. | Ditto | Ditto. |
| 17 | Report of the Agricultural Stations of the Western Circle, United Provinces of Agra and Oudh for the year 1913-14. Price As. 8 or 9d. | Ditto | Ditto. |
| 18 | Annual Report of the Department of Agriculture, Punjab, for the year ending 30th June 1914. Price As. 7 or 7d. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 19 | Year Book of the Punjab Agricultural Department, 1915. | Ditto | Ditto. |
| 20 | Season and Crop Report of the Punjab for the year 1913-14. | Ditto | Ditto. |
| 21 | Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1913-14. Price As. 14 or 1s. 4d. | Issued by the Department of Agriculture, Bombay. | Government Central Press, Bombay. |
| 22 | Season and Crop Report of the Bombay Presidency for 1913-14. Price As. 5 or 6d. | Ditto | Ditto. |
| 23 | Present State of the Dairying Industry in Bombay, Bulletin No 56 of the Department of Agriculture, Bombay. Price As. 3 or 3d. | J. B. Knight, M.Sc., Professor of Agriculture, and E. W. Horn, Manager, Government Civil Dairy, Kirkee | Ditto. |

LIST OF AGRICULTURAL PUBLICATIONS
LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

| No. | Title. | Author. | Where published. |
|-----------------------------------|---|--|-----------------------------------|
| <i>General Agriculture—contd.</i> | | | |
| 24 | Improvement of Indigenous Ploughs of Western India, Bulletin No. 57 of the Department of Agriculture, Bombay. Price As. 12 or 1s 2d. | S. S. Godbole, L.C.E., Assistant Professor of Physics, Agricultural College, Poona. | Government Central Press, Bombay. |
| 25 | Prickly Pear Experiments, Bulletin No. 58 of the Department of Agriculture, Bombay. Price As. 14 or 1s. 4d. | E. W. Horn, Manager, Government Civil Dairy, Kirkee. | Ditto. |
| 26 | Common salt and its use as manure in the Konkan Division, Bulletin No. 59 of the Bombay Department of Agriculture. Price As. 3 or 3d. | V. H. Gonehalli, M.A., Extra Deputy Director of Agriculture, Konkan Division. | Ditto. |
| 27 | Note on Sugar Industry and Modern Methods of Sugar Manufacture, Bulletin No. 60 of the Department of Agriculture, Bombay. Price As. 12 or 1s. 2d. | G. N. Sahasrabuddhe, L.Ag. | Ditto. |
| 28 | Sugarcane, its cultivation and Gul manufacture, Bulletin No. 61 of the Department of Agriculture, Bombay. Price As. 5 or 6d. | J. B. Knight, M.Sc., Professor of Agriculture, Poona. | Ditto. |
| 29 | Value of Castration of Deccan Bullocks, Bulletin No. 62 of the Department of Agriculture, Bombay. Price As. 3 or 3d. | | Ditto. |
| 30 | Substitutes for Rab, Bulletin No. 63 of the Department of Agriculture, Bombay. Price As. 3 or 3d. | | Ditto. |
| 31 | The Fodder Problem in the Bombay Presidency. Price As. 2. | Issued by the Government of Bombay. | Ditto. |
| 32 | Agricultural Engineering in the Bombay Presidency. Price As. 2. | Ditto | Ditto. |
| 33 | Report on the Operations of the Department of Agriculture, Madras Presidency, for the official year 1913-14. Price As. 3 or 3d. | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| 34 | Season and Crop Report of the Madras Presidency for 1913-14. Price As. 4. | Board of Revenue (Revenue Settlement, Survey, Land Records and Agriculture), Madras. | Ditto. |
| 35 | Report of the Experimental work of the Palur Agricultural Station for 1913-14. Price As. 1½ or 2d. | G. D. Mehta, L. Ag., B.A., N.D.A., N.D.D., Extra Deputy Director of Agriculture, C. D. | Ditto. |

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

| No. | Title. | Author. | Where published. |
|------------------------------------|--|--|--|
| General Agriculture— <i>contd.</i> | | | |
| 36 | Report of the Experimental work of the Taliparamba Agricultural Station for 1913-14. Price Anna 1 or 1d. | H. C. Sampson, B.Sc., Deputy Director of Agriculture, Southern Division. | Government Press, Madras. |
| 37 | Report of the Experimental work of the Manganallur Agricultural Station for 1913-14. Price Anna 1 or 1d. | Ditto .. | Ditto. |
| 38 | Report of the Experimental work of the Koilpatti Agricultural Station for 1913-14. Price Anna 1 or 1d. | Ditto .. | Ditto. |
| 39 | Report of the Experimental work of the Hagari Agricultural Station for 1913-14. Price Anna 1 Pies 9 or 2d. | Ditto .. | Ditto. |
| 40 | Possible use for oil engines when not required for pumping. Leaflet No. 8 of the Madras Department of Agriculture. | R. W. B. C. Wood, M.A., Principal, Agricultural College, Coimbatore. | Ditto. |
| 41 | Report on the Working of the Department of Agriculture, Central Provinces and Berar, for 1913-14. Price Re. 1 or 1s. 6d. | Issued by the Department of Agriculture, Central Provinces and Berar. | Government Press, Nagpur |
| 42 | Report on the Management of the Provincial and District Gardens, Central Provinces and Berar, for 1913-14. | Ditto .. | Ditto. |
| 43 | Season and Crop Report of the Central Provinces and Berar for 1913-14. Price As. 8 or 9d. | Ditto .. | Ditto. |
| 44 | <i>The Agricultural and Co-operative Gazette.</i> Price per copy As. 2, issued monthly. | Ditto .. | Ditto. |
| 45 | Report on the Operations of the Department of Agriculture, Burma, for the year 1913-14. Price As. 6 or 7d. | Issued by the Department of Agriculture, Burma. | Government Press, Burma, Rangoon. |
| 46 | Report of the Mandalay Agricultural Station for 1913-14. | Ditto .. | Ditto. |
| 47 | The Burma Agricultural Calendar for 1914-15. | Ditto .. | Ditto. |
| 48 | Report of the Agricultural Department, Assam, for the year ending 30th June 1914. Price As. 8 or 9d. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 49 | Annual Report of the Jorhat Agricultural Experiment Station for the year ending 30th June 1914. | Ditto .. | Ditto. |

LIST OF AGRICULTURAL PUBLICATIONS

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

| No. | Title. | Author. | Where published. |
|-----------------------------------|---|---|---|
| <i>General Agriculture—contd.</i> | | | |
| 50 | Annual Report of the Upper Shillong Agricultural Experiment Station for the year ending 30th June 1914. | Issued by the Department of Agriculture, Assam. | Assam Secretariat Printing Office, Shillong. |
| 51 | Annual Report of the Fruit Experiment Station, Shillong, for the year ending 30th June 1914. | Ditto | Ditto. |
| 52 | Annual Report of the Karimganj Agricultural Experiment Station for the year ending 30th June 1914. | Ditto | Ditto. |
| 53 | Annual Report of the Kamrup Sugarcane Experiment Station for the year ending 30th June 1914. | Ditto | Ditto. |
| 54 | Proper Conservation of Cattle Dung and Urine. Leaflet No.1 of 1914 of the Department of Agriculture, Assam. (In English, Bengali, Assami, and Khasi.) | Ditto | Ditto. |
| 55 | Summary of Remarks on the Kharif Crop of the North-West Frontier Province. Price As. 4 or 4d. | ... | North-West Frontier Province Government Press Peshawar. |
| 56 | Annual Report of the Peshawar Agricultural Station at Tarnab in the North-West Frontier Province for the year ending 30th June 1914. | Department of Agriculture, North-West Frontier Province. | Messrs. Thacker, Spink & Co., Calcutta. |
| 57 | Report of an Agricultural Tour in Europe, America, and Japan during 1912-13. | Leslie Coleman, M.A., Ph.D., Director of Agriculture, Mysore. | Government Press, Bangalore. |
| 58 | Report on Agricultural Education, Bulletin No. 3 of the Department of Agriculture, Mysore. | Issued by the Department of Agriculture, Mysore. | Ditto. |
| 59 | Distribution of Cambodia Cotton Seed, Circular No. 9 of the Department of Agriculture, Mysore. | Ditto | Ditto. |
| 60 | Smut on <i>Jola</i> , Circular No. 10 of the Department of Agriculture, Mysore. | Ditto | Ditto. |
| 61 | About the Cultivation of Cambodia Cotton, Circular No. 11 of the Department of Agriculture, Mysore. | Ditto | Ditto. |
| 62 | An Improved Method of Making Jaggery, Bulletin No. 21 of the Mysore Industries and Commerce Committee. | Alfred Chatterton, F.C., G.I.E., Director of Industries and Commerce, Mysore. | Vokkaligera Sangha Press, Bangalore. |

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

| No. | Title. | Author. | Where published. |
|-------------------------------------|---|---|---|
| <i>General Agriculture—concl'd.</i> | | | |
| 63 | <i>The Journal of the Madras Agricultural Students' Union</i> (monthly). Annual Subscription Re. 1. | Madras Agricultural Students' Union. | Literary Sun Press, Coimbatore. |
| 64 | <i>Quarterly Journal of the Indian Tea Association.</i> Price As. 6 per copy. | Scientific Department of the Indian Tea Association, Calcutta. | Catholic Orphan Press, Calcutta. |
| 65 | <i>Indian Poultry Gazette</i> (monthly). Subscription Rs. 3 per annum. | Indian Poultry Club, Lucknow. | Mafasilit Electric Printing Works, Mussoorie. |
| 66 | <i>Poona Agricultural College Magazine</i> (quarterly). Annual Subscription Rs. 2. | College Magazine Committee, Poona. | Arya Bhushan Press, Poona. |
| 67 | <i>Indian Agricultural World</i> (monthly). Annual Subscription Rs. 10. | Messrs. P. A. V. Iyer & Co., Triplicane, Madras. | Commercial Press, Madras. |
| AGRICULTURAL CHEMISTRY. | | | |
| 68 | The System Potassium Nitrate, Sodium Chloride, Water. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 7. Price Re. 1 or 1s. 6d. | J. W. Leather, V.D., F.I.C., Imperial Agricultural Chemist and Jatinendra Nath Mukerji, B.A., B.Sc., First Assistant to the Imperial Agricultural Chemist. | Messrs. Thacker, Spink & Co., Calcutta. |
| 69 | The Systems (A) Water, Magnesium Carbonate and Carbonic Acid, (B) Water, Calcium Carbonate, Magnesium Carbonate, and Carbonic Acid. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 8. Price Re. 1 or 1s. 6d. | J. W. Leather, V.D., F.I.C., Imperial Agricultural Chemist and Jatinendra Nath Sen, M.A., Supernumerary Agricultural Chemist. | Ditto |
| 70 | Studies of an Acid Soil in Assam. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 9. Price Re. 1-8-0 or 2s. 6d. | A. A. Meggitt, B.Sc., Agricultural Chemist, Assam. | Ditto. |
| 71 | The Gases of Swamp Rice Soils, Part II, their Utilization for the Aeration of the roots of the Crop. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IV, No. 1. Price Re. 1 or 1s. 6d. | W. H. Harrison, M.Sc., Agricultural Chemist to the Government of Madras and P. A. Subramania Iyer, B.A., Assistant to the Govt. Agricultural Chemist, Madras. | Ditto. |
| 72 | Investigation on the Usar Land in the United Provinces. | J. W. Leather, V.D., F.I.C., Imperial Agricultural Chemist. | Government Press, U. P., Allahabad. |
| 73 | The Use of Sweet Jowar (<i>Sorghum</i> sp.) as a source of commercial sugar or as fodder and the variation in the composition of the crop during growth. Bulletin No. 41 of the Agricultural Research Institute, Pusa. Price As. 2 or 3d. | H. E. Annett, B.Sc., F.I.C., Agricultural Chemist to the Government of Bengal. | Superintendent, Government Printing, India, Calcutta. |

LIST OF AGRICULTURAL PUBLICATIONS

LIST OF AGRICULTURAL PUBLICATIONS—contd.

| No. | Title. | Author. | Where published. |
|--------------------------------------|--|--|---|
| <i>Agricultural Chemistry—contd.</i> | | | |
| 74 | Notes on the Cane Crushing in the United Provinces. Bulletin No. 42 of the Agricultural Research Institute, Pusa. Price As. 2 or 3d. | G. Clarke, F.I.C., Agricultural Chemist to the Government, United Provinces, Naib Hussain and S. C. Bannerji, assisted by Lakshmi Shankar. | Superintendent, Government Printing, India, Calcutta. |
| 75 | The Acid Secretion of the Gram Plant (<i>Cicer arietinum</i>). Bulletin No. 45 of the Agricultural Research Institute, Pusa. Price As. 2 or 3d. | D. L. Sahasrabuddhe, B.Sc., L.A.G., Assistant Professor of Chemistry, Agricultural College, Poona. | Ditto. |
| BOTANY. | | | |
| 76 | The Influence of the Environment on the Milling and Baking qualities of Wheat in India, No. 3. The Experiments of 1911-12. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VI, No. 8. Price Re. 1 or 1s. 6d. | A. Howard, C.I.E., M.A., Imperial Economic Botanist, H. M. Leake, M.A., Government Economic Botanist, United Provinces, and G. L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist. | Messrs. Thacker Spink & Co., Calcutta. |
| 77 | The Peas and Beans of Burma. Bulletin No. 12 of the Department of Agriculture, Burma. | E. Thompstone, B.Sc., Deputy Director of Agriculture, Burma, and A. M. Sawyer, Assistant Botanist, Burma. | Government Press, Rangoon. |
| MYCOLOGY. | | | |
| 78 | A List of Diseases of Economic Plants occurring in the Bombay Presidency. Bulletin No. 65 of the Department of Agriculture, Bombay. Price As. 4 or 5d. | H. M. Chibber, M.A., Assistant Professor of Botany, Agricultural College, Poona. | Government Central Press, Bombay. |
| 79 | The <i>Mahali</i> or <i>Koleroga</i> Disease of Areca nuts. | W. MacRae, M.A., B.Sc., Government Mycologist, Madras. | Government Press, Madras. |
| ENTOMOLOGY. | | | |
| 80 | <i>Hindustan me Lakh ki kast;</i> Hindi translation of Bulletin No. 28 of the Agricultural Research Institute, Pusa. Price As. 8. | C. S. Misra, B.A., First Assistant to the Imperial Entomologist, Pusa. | Baptist Mission Press, Calcutta. |
| 81 | <i>Tunt Resham Shilp Sambandha Updesh.</i> Bengali translation of Bulletin No. 39 of the Agricultural Research Institute, Pusa. Price As. 4. | M. N. De, Sericultural Assistant to the Imperial Entomologist, Pusa. | Ditto. |
| 82 | Some South Indian Insects and other Animals of Importance considered especially from an economic point of view. Price Rs. 6 or 9s. | T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist to the Government of India (<i>late</i> Government Entomologist, Madras.) | Government Press, Madras. |

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

| No. | Title. | Author. | Where published. |
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Entomology—contd.

| | | | |
|----|---|---|------------------------------|
| 83 | Instructions for collecting and forwarding Specimens of Insects damaging Crops. Leaflet No. 2 of the Department of Agriculture, Assam. (In English, Bengali, Assami and Khasi.) | Department of Agriculture, Assam. | Secretariat Press, Shillong. |
| 84 | Sericulture in Mysore. Plans of Stands and Trays for the new models of Silk-Worm Rearing House. | Signor W. Mari, Silk Expert, Mysore. | Government Press, Bangalore. |
| 85 | Sericulture in Mysore. Some Illustrations. | Ditto | Ditto. |
| 86 | Rational Sericulture—Plans of Rearing Schools and Rearing Houses. | Ditto | Ditto. |
| 87 | Sericulture. Report of work done by Signor W. Mari during the year 1914. | Issued by the Mysore Economic Conference, Agricultural Committee. | National Press, Bangalore. |

AGRICULTURAL BACTERIOLOGY.

| | | | |
|----|--|---|---|
| 88 | Green Manuring Experiment, 1912-13. Bulletin No. 40 of the Agricultural Research Institute, Pusa. Price As. 4 or 5d. | C. M. Hutchinson, B.A., Imperial Agricultural Bacteriologist, and S. Milligan, M.A., B.Sc., Imperial Agriculturist. | Superintendent, Government Printing, India, Calcutta. |
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VETERINARY.

| | | | |
|----|---|--|---|
| 89 | Bursati. Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. II. No. 5. Price Re. 1-8 or 2s. 3d. | Major J. D. E. Holmes, C.I.E., M.A., D.Sc., M.R.C.V.S., Imperial Bacteriologist, Muktesar. | Messrs. Thacker, Spink & Co., Calcutta. |
| 90 | Experiments on the Treatment of Surra in Camels. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. II, No. 6. Price Re. 1 or 1s. 6d. | H. E. Cross, M.R.C.V.S., D.V.H., A.Sc., Camel Specialist. | Ditto. |
| 91 | Anthrax. Some Experiments on the Immunizing Effect of the simultaneous Injection of an Anthrax attenuated Virus and Anthrax Anti-Serum. Memoirs of the Department of Agriculture, Veterinary Series, Vol. II, No. 7. Price Re. 1 or 1s. 6d. | Major J. D. E. Holmes, C.I.E., M.A., D.Sc., M.R.C.V.S., Imperial Bacteriologist, Muktesar. | Ditto. |
| 92 | A Note on the Effect of Heat on the Rinderpest Immune Bodies. Bulletin No. 43 of the Agricultural Research Institute, Pusa. Price As. 2 or 3d. | Ditto | Superintendent, Government Printing, India, Calcutta. |

ENTOMOLOGICAL SERIES.

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Vol. II, No. I. The Rice Bug, by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1.

Vol. II, No. II. Remarks on Indian Scale Insects (Coccidæ), Part III, by E. E. GREEN, F.E.S., F.Z.S. Price, Re. 1-8.

Vol. II, No. III. The Red Cotton Bug, by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1. (*Out of print.*)

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Vol. II, No. X. Life-Histories of Indian Insects—III. The Rhinoceros Beetle (*Oryctes rhinoceros*) and the Red or Palm Weevil (*Rhynchosphorus ferrugineus*), by C. C. GHOSH, B.A. Price, Re. 2.

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